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ABSTRACT

The first 80 pages of the guide are arranged in vertical columns relating the biology curriculum concepts to curriculum performance objectives, career concepts and career performance objectives, suggested teaching methods, and resource materials. Career information on 41 occupations includes comments on what a person in the occupation does, the level of education required, approximate salary range, approximate number of people in the field, and employment opportunities. Space is provided for teachers' additions, deletions, notes, and criticisms, which will be useful when the guide is revised. The next 50 pages contain biology laboratory exercises. Audio-visual source information, selected references, additional sources of career information, and periodicals are listed in the appendix. (AG)

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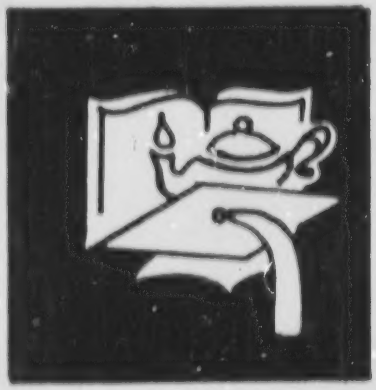

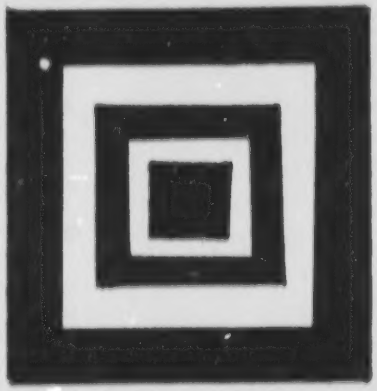

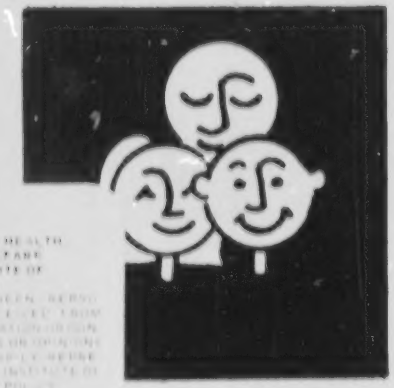

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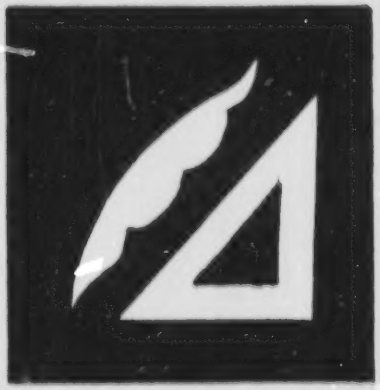

Career - Curriculum Guide

CAREER EDUCATION CENTER

HARLANDALE INDEPENDENT SCHOOL DISTRICT
3706 ROOSEVELT
SAN ANTONIO, TEXAS 78214

BIOLOGY II

CE 001 087

CURRICULUM GUIDE

BIOLOGY II

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San Antonio, Texas

A C K N O W L E D G E M E N T S

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FOREWORD

"...a book cannot tell you how to be creative. It may cause you to see something differently, or to do something you have not done before, or to understand better what you have been doing all along. At best, a book can only start you off on a way of your own and be a resource to you as you go ahead. It can do little, compared to what you yourself must do."

--Evelyn Wenzel

from "The Come-Alive Classroom" by Cook, Caldwell & Christensen

Dear Teacher:

This curriculum guide has been prepared to help you as you endeavor to fulfill your teaching responsibilities. Please feel free, as you use it, to add your comments, suggestions and constructive criticism in the appropriate column as these will be needed when the guide is revised at the end of the school year. Also any additional resource materials which you feel would be beneficial and should be included can be added at your discretion. If I can be of any assistance during the school year, please feel free to contact me at any time.

Mr. Angelo Russo
Science Consultant
Career Education Center
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Preface

Meaningful existence is the goal of life in today's world. Living takes on meaning when it produces a sense of self-satisfaction. The primary task of education must be to provide each individual with skills necessary to reach his goal.

When children enter school, they bring with them natural inquisitiveness concerning the world around them. Normal curiosity can be the nucleus which links reality to formal training if it is properly developed. A sense of continuity must be established which places education in the correct perspective. Communities must become classrooms and teachers resource persons. Skills such as listening, problem solving, following directions, independent thinking and rational judgement then can merge into daily living procedures.

In classrooms especially designed to form a bridge between school and the world of work, experiences must be developed. On campus performance in job tasks and skills, following a planned sequence of onsite visitation, will fuse information into reality. Practical relationships developed with those outside the formal school setting will provide an invaluable carry-over of learned skills.

Search for a rewarding life vocation is never easy. Without preparation it becomes a game of chance. With a deliberate, sequential, and planned program of development, decisions can be made based upon informed and educated judgements.

A full range career education program, K-12, will offer opportunities for participants to enter employment immediately upon completion of training, post secondary vocational-technical education, and/or a four-year college career preparatory program.

C. N. Boggess

C. N. Boggess, Superintendent
Harlandale Independent School District

The Career Education Project has been conducted in compliance with the Civil Rights Act of 1964 and is funded by a grant from the U. S. Office of Education and the Texas Education Agency.

Philosophy

It is becoming increasingly apparent that a thorough familiarity with basic scientific principles is necessary to live as an informed citizen in today's highly technological society and those who lack this understanding and appreciation will no doubt contribute little to future scientific progress. One of our primary objectives is to provide all students with not only knowledge in the conceptual domain but also in the affective and psychomotor as well, for we believe in the total development of each child to his fullest potential.

Preparation for life must be as broad as possible so as to allow the individual to possess the necessary information upon which to base his life's decisions. A critical decision, and one not to be taken lightly, is the selection of a life's work. We are attempting, for the first time, to provide not only subject matter preparation but career preparation as well. To be well-versed in a subject and know little about it's usefulness, application and significance is to be ill-equipped for modern living.

Hopefully as the students climb our conceptual ladder in the academic realm they will simultaneously be preparing themselves for a specific career or occupation. Upon graduation from the high school, a clear and definite plan for future endeavors will have already been formulated and the means for the fulfillment of those plans will be evident. Whether they are going to college, a technical school or directly entering the world of work, success will be virtually assured.

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Note: The textbook adopted by the Harlandale Indeperdent School District is entitled Biology by Johnson, Laubengayer, DeLanney and Cole. A laboratory manual accompanies the text.

BIOLOGY II

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
INTRODUCTION -characteristics of life -subdivisions of biological study -historical aspects of biology	The student should be able to: 1. Distinguish orally, using the major characteristics of life, between an animate and inanimate object. 2. List at least fifteen subdivisions of biology and indicate the primary concern of each. 3. Write a one page report briefly describing the more important events occurring during the progressive development of biological science.	CONCEPT: Biological science offers those who are interested a great variety of career opportunities. OBJECTIVE: The student should be able to list at least two occupations in biology which he might consider for his life's work and give the reasons for his choices.	OCCUPATIONS IN BIOLOGICAL SCIENCE 1. Medical Laboratory Assistant 2. Biological Researcher 3. Food Technologist 4. Medical Librarian 5. Entomologist 6. Anesthesiologist 7. Psychiatrist 8. Pathologist 9. Fruit Farmer 10. Tree Experts 11. Genetic Counselor 12. Livestock Farmer 13. Wildlife Manager 14. Registered Nurse 15. Botanist

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the student bring in newspaper and magazine articles and pictures dealing with the many subdivisions of biology to be displayed on the class bulletin board. 2. Show and discuss the film entitled Biology in Today's World which is available from ESC Region 20. 3. Show and discuss any of the filmstrips in the Great Names in Biology Series available from the Harlandale Audio-Visual Center. 4. Have interested students, as an extra credit assignment, prepare a written report on any historical figure in the life sciences. CAREER: 1. Have interested students write a research report, using the Occupational Outlook Handbook, on any occupation related to biology. 2. Show and discuss the filmstrip entitled Choosing Your Career which is available from the Harlandale Audio-Visual Center. 3. Have interested students interview a life scientist at one of the local colleges and report to the class.	CURRICULUM: ESC REGION 20: Films: #4068 Biology in Today's World #8298 Origin of Life HARLANDALE AUDIO-VISUAL CENTER: Filmstrip: A-89 Thru A-94 Great Names in Biology Series CAREER: HARLANDALE AUDIO-VISUAL CENTER: Record w/filmstrip: PR-340 Choosing Your Career PR-357 What You Should Know Before You Go To Work SCHOOL LIBRARY OR COUNSELOR'S OFFICE: Occupational Outlook Handbook Dictionary Of Occupational Titles Encyclopedia Of Careers	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-scientific method -hypotheses, theories and laws -attitudes of scientists -levels of organization of living things	The student should be able to: 1. Write a one page description illustrating the use of the scientific method in the solution of a hypothetical problem. 2. Describe orally at least three attitudes which should be possessed by scientists. 3. Define and use in a complete sentence each of the following terms: a) hypothesis b) theory c) law d) experimental control e) variable	CONCEPT: Methods used by law enforcement agencies and criminologists are not unlike those used by the scientist. OBJECTIVE: The student should be able to list at least two advantages and two disadvantages of a career in law enforcement or criminology.	CRIMINOLOGIST 1. The criminologist studies crime, criminals, and the agencies of the criminal justice system with the objective of discovering ways to prevent and control criminal behavior. He is concerned primarily with one or more of three main areas: (1) the process of lawmaking; (2) the process of lawbreaking; and (3) the reaction of society to lawbreaking--the process of correction and its administration. 2. Most criminologists in the United States major in sociology while in college. In practice, however, they draw their knowledge from all fields related to the understanding of crime. A graduate degree is usually held by most criminologists. An interest in people as individuals and as members of groups as well as an interest in social problems is essential. 3. Salaries of criminologists vary according to experience, training, and the type of job. Most criminologists earn anywhere from $10,000 to $35,000 a year depending on the level of responsibility. 4. Opportunities for both men and women are expected to be good in the near future. Those with a doctor's degree will be qualified for top-level positions in this field.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Show and discuss the filmstrip entitled The Scientist - His Way, Your Way available from the Harlandale Audio-Visual Center. 2. Have a panel discussion on What A Scientist Must Be. Afterward have the students summarize the panel discussion in a paragraph or two. 3. Have the students visit a local research establishment or hospital to interview scientific workers about the attributes and qualities necessary to work scientifically 4. Have the students think of a problem. Then ask to design a plan for solving it scientifically. CAREER: 1. Invite a criminologist or local police detective to class to discuss his career. 2. Have interested students interview a law enforcement officer about his work. 3. Have interested students listen to the magnetic tape entitled FBI Special Agents which is available from the Harlandale Audio-Visual Center.	CURRICULUM: HARLANDALE AUDIO-VISUAL CENTER: Filmstrip: The Scientist-His Way, Your Way CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: MT-323 FBI Special Agents SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #[illegible]95 Criminologists Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Sociological Association 1001 Connecticut Avenue, NW Washington, D.C. 20036	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
TOOLS OF BIOLOGY -care and use of the microscope -types of microscopes -light -phase-contrast -electron -centrifugation -chromatography	The student should be able to: 1. Set up and use correctly a light microscope. 2. Compare, in a short written statement, the light microscope with the electron microscope. 3. Explain orally the principle by which a centrifuge operates. 4. Describe, briefly but accurately, at least two chromatographic methods.	CONCEPT: A medical laboratory assistant must be familiar with all of the tools of biology. OBJECTIVE: The student should be able to discuss, in a one page report, the duties and responsibilities of a medical laboratory assistant.	MEDICAL LABORATORY ASSISTANT 1. The duties of a medical laboratory assistant may include collecting blood specimens; grouping and typing blood; analyzing body fluids; examining microscopically, samples of urine, blood, and other materials; administering electrocardiograms and metabolism tests; preparing solutions; keeping records; and cleaning, sterilizing and storing laboratory equipment, glassware, and instruments. Usually the work is supervised by a medical technologist and a qualified physician. 2. Those wishing to become medical laboratory assistants may attend a commercial school, a hospital lab school, or a junior college. In some cases, laboratories provide their own on-the-job training. A high school diploma is required for this occupation. Other requirements include good vision, manual dexterity, the ability to work under pressure and the ability to work cooperatively with others. 3. Salaries for medical laboratory assistants range from $4,000 to about $8,000 depending upon training, educational background and experience. 4. It is projected that 100,000 laboratory assistants will be needed by 1975 due to our expanding population.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do laboratory unit 1, (parts 1 a, b, and c) entitled Microscopic Study in their laboratory manuals. 2. Have interested students create a poster board size, labeled, drawing of a compound microscope to be displayed on the class bulletin board. 3. If possible, take the class to Trinity University, Brooks A.F.B., or Wilford Hall Hospital to view the electron microscope. 4. Have several class periods during which the students may use the compound microscope to examine specially prepared histological slides. Have them draw and color exactly what they observe in the field of view. 5. If possible, have the students prepare permanent slides from specimens they themselves have collected. A handout sheet with the directions can be prepared and distributed by the teacher. CAREER: 1. Invite a local medical laboratory assistant to class to talk about his or her work. 2. Have interested students visit a hospital and interview a medical laboratory worker. 3. Have interested students listen to the magnetic tape entitled Medical Laboratory Worker which is available from the Harlandale Audio-Visual Center.	CURRICULUM: ESC REGION 20: Film: #2217 What Is a Cell? CAREER: ESC REGION 20: Film: #2326 In a Medical Laboratory HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: MT-300 Medical Laboratory Worker SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #290 Medical Assistant SRA Occupational Brief #382 Medical Laboratory Assistant and Technician Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Society of Medical Technologists Hermann Professional Building Houston, Texas 77025	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
CELL THEORY -cellular structure -cell wall -plasma membrane -cytoplasm -E.R. -mitochondria and Gulgi bodies -nucleus and chromosomes -lysosomes -cilia fingella and other organelles -animal and plant cell differentiation -diffusion and osmosis	The student should be able to: 1. List each of the structures found in a "typical" cell and give at least one function of each. 2. Identify, in writing, at least three differences between an animal cell and a plant cell. 3. Differentiate orally between diffusion and osmosis and give an example of each of these processes.	CONCEPT: A knowledge of cellular structure is basic to the work of a cytologist. OBJECTIVE: The student should be able to state, in a short paragraph, why he or she would like to be a cytologist.	CYTOLOGIST 1. The cytologist is primarily concerned with cell structure and function. He studies parts of cells, cell division, the formation of reproductive cells and the origins of blood and tissue cells. Frequently the cytologist conducts research into the physiology of unicellular organisms as well as the physiology of malignant cells and their proliferation. 2. A bachelor's degree may be adequate for some beginning jobs, but chances for advancement depend highly upon an advanced degree. Prospective life scientists should be able to work independently, or as part of a team as well as be able to express themselves both orally and in writing. 3. Life scientists in 1970 earned anywhere from $8,700 to $26,100 depending upon training, educational degrees and experience. In general, life scientists in private industry earned higher salaries than those in colleges and universities.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do laboratory units 2 (parts a and b) entitled Structural and Functional Units of Higher Animals in their lab manuals. 2. Show and discuss the film entitled The Cell - Structural Unit of Life available from both ESC Region 20 and the Harlandale Audio-Visual Center. 3. Have the students do laboratory unit 3 entitled The Exchange of Materials between Cells and the Environment; Fine Structure of Cells in the lab manuals. 4. Demonstration Osmosis and Diffusion to the class using suitable apparatus and materials. 5. Show and discuss the film entitled Diffusion and Osmosis available from the Harlandale Audio-Visual Center. CAREER: 1. Invite a cytologist from a medical school to class to discuss his training and his work. 2. Have interested students do a research report on the work of a cytologist using the Occupational Outlook Handbook and the Dictionary of Occupational Titles.	CURRICULUM: ESC REGION 20: Films: #4834 The Cell-Structural Unit of Life #4760 Osmosis HARLANDALE AUDIO-VISUAL CENTER: Films: 16-32 The Cell-Structural Unit of Life 16-616 Diffusion and Osmosis CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: Occupational Outlook Handbook Dictionary Of Occupational Titles	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-animal tissues, organs and systems -epithelial supporting muscle, nervous and vascular -plant tissues, organs and systems -meristems -permanent tissues -parenchyma collenchyma and sclerenchyma	The student should be able to: 1. Distinguish orally between a tissue, an organ and a system. 2. Name an organ which is composed of each of the following tissues: a) epithelial b) muscle c) nervous d) vascular 3. State, in a short statement, the difference between meristematic and permanent plant tissues. 4. Define or describe each of the following plant tissues: a) parenchyma b) collenchyma c) sclerenchyma	CONCEPT: Tissues, organs and systems are the primary concern of the anatomist. OBJECTIVE: The student should be able to describe, in a short paper, the duties and responsibilities of an anatomist.	ANATOMIST 1. An anatomist studies the structure and form of animals. He usually examines the large organs of the body by careful observation and often by dissection. Microscopic examination of minute structures, tissues and cells are also a part of his work. The anatomist makes comparative studies of one species with another and conducts basic research into the laws of biological science. 2. A Ph.D. in biological science is the usual basic requirement for those seriously wanting to do significant research. However, new graduates having the master's degree may qualify for most entry positions in applied research and college teaching. 3. Beginning salaries for life scientists vary from $6,548 to $14,192 depending on degrees attained. 4. A rapid increase in employment in the life sciences is expected through the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do laboratory unit I (part 2) entitled The Structural and Functional Units of Plants in their laboratory manuals. 2. Show and discuss the film entitled The Plant Organism or Tissues of The Human Body available from the Harlandale Audio-Visual Center. 3. Have the students do laboratory unit II (part c) entitled Structure of an Organ - The Intestine in their laboratory manuals. 4. Have the students prepare labeled notebook drawings of all major plant and animal tissues. CAREER: 1. Invite an anatomy professor from a local university to class to talk about his work. 2. Have interested students write to the American Institute of Biological Science for further career information.	CURRICULUM: ESC REGION 20: Films: #8622 Growth of Plants #2149 The Plant Organism HARLANDALE AUDIO-VISUAL CENTER: Films: 16-188 Characteristics of Plants and Animals 16-139 Roots of Plants 16-385 Tissues of the Human Body CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: Occupational Outlook Handbook Dictionary Of Occupational Titles Encyclopedia Of Careers WRITE TO: American Institute of Biological Sciences 3900 Wisconsin Avenue Washington, D.C. 20016	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-cell division -animal and plant mitosis -phases of mitosis -meiosis -spermatogenesis -oogenesis	The student should be able to: 1. Differentiate, in a short statement, between plant and animal cell mitosis. 2. When present with a list of events occurring during mitosis, identify correctly in which phase the event is evident. 3. Draw a schematic drawing depicting the process of spermatogenesis; of oogenesis. Be sure to include an accurate explanation of each process.	CONCEPT: A thorough knowledge of cell growth and division is essential to the cancer researcher. OBJECTIVE: The student should be able to list at least one advantage and one disadvantage of being a cancer researcher	CANCER RESEARCHER 1. The primary concern of the cancer researcher is the investigation of the causes of the many types of cancer. This investigation has, in recent years, been responsible for the steady increase in the number of patients who have been cured of this disease. Another concern of these scientists is the development of improved methods of diagnosis. 2. At the very least, the beginning researcher requires a bachelor's degree with a major in biology and a minor in chemistry. Graduate training is usually necessary for the more responsible positions in teaching and research. 3. Numerous opportunities exist for those who have the credentials. The researcher may advance to the position of project chief and be responsible for other workers under him or he may be promoted to an administrative or management position. 4. The American Institute of Biological Sciences estimates that over 5,400 jobs will open up each year for those entering the field of biology.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Using overhead transparencies, discuss Mitosis and Meiosis. 2. Show and discuss the film entitled Mitosis and Meiosis available from the Harlandale Audio-Visual Center. 3. As a special project, have the students make clay or plaster models depicting either meiosis and mitosis. A prize could be awarded the best project. 4. Have the students write to or visit the local office of the American Cancer Society for materials concerning normal and abnormal cell growth. 5. Have the students do laboratory Unit 13 entitled Mitosis and Meiosis in their laboratory manuals. CAREER: 1. Invite a research worker from the School of Aerospace Medicine to class to discuss his career. 2. Have interested students visit the Southwest Institute for Research and Education and interview a research worker. 3. Have interested students listen to the cassette tape entitled Research Scientist which is available from the Harlandale Audio-Visual Center.	CURRICULUM: ESC REGION 20: Films: #2024 Cell Reproduction-Mitosis #8629 Meiosis-Sex Cell Formation #8631 Mitosis HARLANDALE AUDIO-VISUAL CENTER: Film: 16-351 Mitosis and Meiosis CAREER: HARLANDALE AUDIO-VISUAL CENTER: Cassette Tape: Cas T-34 Research Scientist SCHOOL LIBRARY OR COUNSELOR'S OFFICE: Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Physiological Society 9650 Rockville Pike Bethesda, Maryland 20014	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
ENERGY AND THE CELL -potential and kinetic energy -ADP and ATP -photosynthesis -role of chlorophyll -light phase -dark phase -cellular respiration -glycolysis -kreb's cycle -hydrogen transport -metabolic mill	The student should be able to: 1. Explain, in a short paragraph, the rule of ADP and ATP in the functioning of the cell. 2. Decribe, accurately, using a schematic drawing, the light phase of photosynthesis; the dark phase. 3. Outline, using chemical equations, the basic reactions of the kreb's cycle. 4. Define, briefly, but accurately, in written form, what is meant by the hydrogen transport system and the metabolic mill.	CONCEPT: Chemical activity and energy requirements of living things are significant aspects of the work of a biochemist. OBJECTIVE: The student should be able to list at least two reasons why he or she would or would not like to be a biochemist.	BIOCHEMIST 1. Currently there are about 11,300 biochemists working in the United States. Most of these are applying their knowledge in the fields of medicine, bromedicine, nutrition and agriculture. Their work includes investigating the causes and cures of disease; studying brain function and physiological adaptation; examining the effects of food deficiencies; discovering more efficient methods of crop cultivation and storage; and designing more effective pest control agents. 2. Biochemists just beginning may have just the bachelor's degree but it is advisable to obtain an advanced degree if one expects to assume positions of higher responsibility. Some graduate students in biochemistry become research or teaching assistants in colleges and universities. Later they may qualify for professorships when they receive their advanced degrees. 3. Median salaries for biochemists in 1970 ranged from $9,900 for those with a bachelor's degree to $15,000 for those with a doctorate. 4. The prospects for the coming decade in this field are good.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS

CURRICULUM:

1. In a chalktalk, present in detail both the light phase and dark phase of photosynthesis

2. Show and discuss any of the film available from ESC Region 20 or the Harlandale Audio-Visual Center concerning cellular respiration and photosynthesis.

3. Have the students do Exercise "A" entitled Respiration and Exercise "B" entitled Photosynthesis found in the appendix of this guide.

4. Have interested students prepare a detailed poster size schematic flow chart depicting cellular respiration or photosynthesis.

CAREER:

1. Invite a biochemist to class to discuss his training and his work.

2. Have interested students interview a biochemist at a local college.

3. Have interested students listen to the magnetic tape entitled Biochemists which is available from the Harlandale Audio-Visual Center.

4. Have interested students write to the American Chemical Society for further career information.

CURRICULUM:

ESC REGION 20:
Films: #2025 Cell Respiration
#2028 Chemical Organization of the Cell
#2031 Chlorophyll
#8690 The Magic of the Atom-Riddle of Photosynthesis
#2286 Photosynthesis

HARLANDALE AUDIO-VISUAL CENTER:
Film: 16-427 Photosynthesis-Chemistry of Food-Making
16-126 Plant Growth
Filmstrip: K-79 Enzymes-The Spark Plugs of Life
Transparency: TP-9 Leaf Photosynthesis

CAREER:

HARLANDALE AUDIO-VISUAL CENTER:
Magnetic Tape: MT-306 Biochemists

SCHOOL LIBRARY OR COUNSELOR'S OFFICE:
SRA Occupational Brief #131 Biochemists

Occupational Outlook Handbook

WRITE TO:

American Chemical Society
1155 Sixteenth Street, NW
Washington, D.C. 20006

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
STRUCTURE OF MATTER -atomic structure -atomic mass -atomic number -bonding -elements and compounds -mixtures	The student should be able to: 1. Draw accurately a diagram of the atomic structure of at least ten different atoms selected by the teacher. 2. Distinguish orally between atomic mass and atomic number. 3. When presented with a list of 25 substances, state, with 80% accuracy which are elements and which are compounds. 4. Name at least five elements which are commonly found in a living cell.	CONCEPT: A knowledge of elements and compounds is essential to the pharmacist. OBJECTIVE: The student should be able to discuss in a short paragraph why he or she would or would not choose pharmacy as a career.	PHARMACIST 1. The pharmacist works with a variety of measuring and mixing devices and with beakers, bottles and test tubes in the compounding of drugs. Some pharmacists are in research, hoping to develop new drugs or improve old ones while others supervise the preparation of ingredients which go into capsules, ointments, or other products of the manufacturer. Pharmacists also may teach in one of the 74 accredited colleges of pharmacy in this country. 2. Requirements for this profession include at least a bachelor's degree in pharmacy, an internship and the passing of a state board examination. Most young pharmacists begin in a community or hospital pharmacy on a salaried basis and many advance to higher levels of responsibility after some experience. 3. Average salaries for beginning pharmacists in 1970 ranged from $8,000 to $14,000 a year depending on the size and location of the position he takes. 4. Employment opportunities in this field should be quite good in the next decade.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Show and discuss the film entitled Biochemistry and Molecular Structure or Elements, Compounds and Mixtures available from ESC Region 20. 2. Lecture on atomic structure using any of the filmstrips available from the Harlandale Audio-Visual Center. 3. Have the students, as a special project, build styrofoam models of the more common atoms. CAREER: 1. Ask a local pharmacist to come to class and talk about his career. 2. Have interested students visit a pharmacy to interview the druggist about his career. 3. Have interested students listen to either of the available tapes dealing with the occupation of pharmacist. 4. Have interested students write to the American Pharmaceutical Association for further career information.	CURRICULUM: ESC REGION 20: Films: #8563 Biochemistry and Molecular Structure #2260 Elements, Compounds and Mixtures HARLANDALE AUDIO-VISUAL CENTER: Films: 16-500 Our Friend, the Atom, Part 1 16-501 Our Friend, the Atom, Part 2 Filmstrips: K-54 Atomic Structure and Chemistry K-57 Orbitals-Atom and Molecular CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: MT-298 Pharmacists Cassette Tape: Cas T-34 Pharmacist SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #74 Pharmacists Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Pharmaceutical Association 2215 Constitution Avenue, NW Washington, D.C. 20037	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
LIVING MATTER -organic constituents -carbohydrates -lipids -proteins -nucleic acids -DNA -RNA -inorganic constituents -water -acids, bases, and salts -gases	The student should be able to: 1. Explain, in a one page paper, the role of carbohydrates, lipids, proteins and nucleic acids in the functioning of the cell. 2. Distinguish, in written form, between the primary, secondary and tertiary structure of a protein. 3. Draw the structure of DNA and explain its role in the cell. Do the same for RNA. 4. Define, in a short statement, each of the following terms: a) acid b) base c) salt d) electrolyte e) anions f) cations g) ph	CONCEPT: The organic constituents of living matter are one of the chief concerns of the food technologist. OBJECTIVE: The student should be able to list at least three duties or responsibilities of a food technologist.	FOOD TECHNOLOGIST 1. The food technologist is concerned with the producing, processing, packaging, distributing and preparing of foods. He attempts to improve the quality of foods while trying to maintain or increase its nutritional value. In 1967 it was estimated that about 10,000 trained food technologists were working in this field. 2. Essential qualifications include a bachelor's degree in food technology, an active imagination and a genuine interest in science. Also, one should possess a high degree of reasoning and mathematical ability. Those wishing to advance to higher level positions should have at least a master's degree in this field. 3. Median salaries for those beginning in this occupation were about $625 a month for B.S. graduates in 1967. 4. Outlook for this industry seems to be quite favorable through the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. In a chalktalk, discuss the structure and functions of all the important organic and inorganic constituents of living matter. 2. Have the students do a written research report on any of the inorganic or organic constituents of matter. 3. Have interested students, as a special project, build a model of DNA. 4. Show and discuss the film entitled Carbon and Its Compounds available from the Harlandale Audio-Visual Center. 5. Show and discuss the filmstrip entitled DNA Code of Life available from the Harlandale Audio-Visual Center. CAREER: 1. Invite a food technologist to class to discuss his or her occupation. 2. Have interested students write a research report on the occupation of food technologist using the SRA Occupational Brief entitled Food Technologists which is available from the school library or counselor's office. 3. Have interested students write to the Institute of Food Technologists for further career information.	CURRICULUM: HARLANDALE AUDIO-VISUAL CENTER: Film: 16-29 Carbon and It's Compounds Filmstrip: K-82 DNA Code of Life CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #215 Food Technologist Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: Institute of Food Technologists 221 North LaSalle Street Chicago, Illinois 60601	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
TAXONOMY -Linnaeus and his contribution -categories of classification -criteria for animal classification -criteria for plant classification -problems in classification	The student should be able to: 1. State orally at least one reason for animal and plant classification. 2. List, in ascending order, the seven categories of classification and correctly classify man with these categories. 3. Name at least seven important criteria used in the classification of an animal. 4. Name at least five criteria used in the classification of a plant.	CONCEPT: Classification is important in the work of a medical librarian. OBJECTIVE: The student should be able to write a short paragraph describing the work of a medical librarian.	MEDICAL LIBRARIAN 1. The medical librarian manages the medical library for such institutions as schools and hospitals. The librarian arranges technical books, periodicals, catalogs, film strips, motion pictures, micro cards, and journal reprints. He or she also compiles accession lists, annotates or abstracts materials and also assists patrons in research problems. The medical librarian may also translate or order translation of materials from foreign languages into English. 2. The minimum requirement is a bachelor's degree plus at least one year of graduate training in a library school. Most employers require a master's degree in library science. Certification at three levels in this field can be obtained from the Medical Library Association. 3. Beginning salaries for medical librarians range from $6,500 to $7,500 a year. Top positions in this occupation can have values as high as $25,000 a year. 4. Qualified medical librarians will be increasingly needed in the years ahead due to advances in both science and medicine.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do Laboratory Unit 25 entitled Classification of Animals in their laboratory manuals. 2. Show and discuss any of the following films available from ESC Region 20: a.) Classifying Plants and Animals b.) Order in Diversity c.) The Systematic Scientist 3. Take the class on a tour of the neighborhood. Using suitable keys, have them attempt to identify the more common plant species in the area. 4. Have the students attempt to make a classification key to be used in identifying faculty members in the school. CAREER: 1. Invite a medical librarian from a nearby medical school to class to discuss his or her career. 2. Have interested students visit a medical library and interview the librarian there. 3. Have interested students write to the Medical Library Association for further career information.	CURRICULUM: ESC REGION 20: Films: #4114 Classifying Plants and Animals #2139 Order in Diversity #2194 The Systematic Scientist CAREER: HARLANDALE AUDIO-VISUAL CENTER: Cassette Tape: Cas T-41 Librarian SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #218 Medical Librarian Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: Medical Library Association 919 North Michigan Avenue Chicago, Illinois 60611	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
PROTOZOA -types of nutrition -classes of protozoa -mastigophora -sarcodina -ciliata -suctoria -sporozoa -respiration, excretion and reproduction of protozoa -metazoan development -syncytial theory -colonial theory	The student should be able to: 1. Distinguish orally between holozoic, saprophytic and holophytic nutrition. 2. Name the primary feature of each of the classes of protozoa. 3. Describe and explain in a written paragraph, the process of conjugation in paramecia. 4. Explain, in a short paragraph or two, the two theories of metazoan development.	CONCEPT: A knowledge of protozoan life functions and physiology is essential to the protozoologist. OBJECTIVE: The student should be able to describe orally what it would be like to be a protozoologist.	PROTOZOOLOGIST 1. The protozoologist is primarily concerned with the study of the development, functions, life history, and behavior of protozoans. He frequently specializes in the life processes (digestion, circulation, excretion, respiration, and the like) and the way these microscopic organisms perform them. 2. A college degree is essential for the protozoologist and only those who are extremely interested in science and have high scholastic records should consider a career in this field. For positions in college teaching, administration and advanced research, the doctorate degree is required. 3. The average salary for biologists in all kinds of employment in 1966 was about $12,000 with the top 10% earning $20,000 or more. 4. Present opportunities for animal scientists are very good provided they have obtained an advanced degree.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS

CURRICULUM:

1. Have the students do Laboratory Unit 26 entitled Protozoans in their laboratory manuals.

2. Show and discuss any of the films on protozoans available from ESC Region 20.

3. Have the students do laboratory exercise "C" entitled Food Pyramid in a Hay Infusion Jar found in the appendix of this guide.

4. Have the students examine prepared permanent slides of various protozoans and have them make labeled notebook drawings of their observations.

CAREER:

1. Invite a zoologist from a local college to class to talk about opportunities in this field.

2. Have interested students read the SRA Occupational Brief entitled Zoologists which is available from the school library or counselor's office.

3. Have interested students write to the American Society of Zoologists for further career information.

CURRICULUM:

ESC REGION 20:
Films: #2007 Ameboid Organisms
#2060 Form and Function
#8204 The Invertebrates
#4855 Life Story of the Paramecium
#8721 Paramecium, Euglena and Ameba
#8644 Single-Celled Animals-Protozoa

HARLANDALE AUDIO-VISUAL CENTER:
Film: 16-132 Protozoa (One-celled animals)

CAREER:

SCHOOL LIBRARY OR COUNSELOR'S OFFICE:
SRA Occupational Brief #180
Zoologists

Occupational Outlook Handbook

Dictionary Of Occupational Titles

WRITE TO:

American Society of Zoologists
Dr. John Shaver, Secretary
Department of Zoology
Michigan State University
East Lansing, Michigan 48823

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
SPONGES AND COELENTERATES -asconoid, syconoid and leuconoid sponges -authozoa -metridium -scyphozoa -aurelia -hydrozoa -hydra and obelia	The student should be able to: 1. Differentiate, by means of hand drawn sketches, between asconoid, syconiod and leuconoid sponges. 2. Label correctly, a drawing of either metridium or aurelia and give the function of each of the parts. 3. Describe, in written form, the structure of hydra. 4. Outline schematically the life cycle of obelia.	CONCEPT: Knowledge of these two phyla of invertebrates is important to the marine biologist. OBJECTIVE: The student should be able to write a paragraph describing the activities of a marine biologist.	MARINE BIOLOGIST 1. The marine biologist studies plants and animals living in salt water and the environmental conditions which affect them. They frequently investigate water temperature, light, oxygen content, and other factors which are related to aquatic life as well as examine various types of water life. 2. The Ph.D. degree is essential in this field if one expects to do original research or occupy a high level position. Many prospective marine biologists combine graduate study with positions as research assistants. Personal qualifications such as patience, perserverence, accuracy and the ability to work without supervision are also necessary for success as a marine biologist. 3. Marine biologists earned from $7,500 up to $20,000 a year depending on educational preparation and experience. 4. Opportunities during the next decade are expected to be good for those with advanced degrees.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the student do Laboratory Unit 27 entitled Simple Multicellular Animals in their laboratory manuals. 2. Show and discuss any of the following films: a.) First Many - Celled Animals - The Sponges b.) Stinging - Celled Animals - Coelenterates 3. If possible, take the class on a field trip to the Gulf Coast to collect as many specimens as possible. (Perhaps a Saturday trip can be arranged) 4. Have interested students make a bulletin board display of magazine pictures of sponges and coelenterates. CAREER: 1. Invite a marine biologist from a local college to class to talk about his training and his career. 2. Have interested students listen to the magnetic tape entitled Oceanographers which is available from the Harlandale Audio-Visual Center. 3. Have interested students read the SRA Occupational Brief entitled Oceanographers which is available from the school library of counselor's office.	CURRICULUM: ESC REGION 20: Films: #8610 First Many-Celled Animals - The Sponges #8646 Stinging - Celled Animals - Coelenterates HARLANDALE AUDIO-VISUAL CENTER: Filmstrip: C-99 Plants and Animals Under the Sea CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic tape: MT-305 Oceanographers SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #188 Oceanographers Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Society of Limnology and Oceanography W. K. Kellogg Biological Station Hickory Corners, Michigan 49060	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
PLATYHELMINTHES -general features and advances -classes of flatworms -turbellaria -planarians features -trematoda -clonorchis structure -cestoda -taenia anatomy NEMATHELMINTHES -general characteristics and advances -ascaris and other parasitic nematodes -rotifers	The student should be able to: 1. Compare and contrast, in tabular form, the characteristics of flatworms and roundworms. 2. Label correctly, with 90% accuracy, anatomical drawings of each of the following: a) planaria b) clonorchis sinensis c) taenia saginata d) ascaris 3. Outline and explain the life cycle of each of the following: a) clonorchis b) taenia saginata c) ascaris	CONCEPT: Since a parasitic mode of life is a distintive feature among many flatworms and roundworms, it is a major concern of the parasitologist. OBJECTIVE: The student should be able to list at least three activities of a helminthologist	HELMINTHOLOGIST 1. A helminthologist is a life scientist who has specialized in one particular are of parasitology where as parasitologists study such animals as protozoans, worms, flukes, mites, ticks and parasitic insects, the helminthologist concentrates on the growth, development and life cycles of parasitic worms. He attempts to develop methods of controlling these worms and eliminating them in infected hosts. 2. As in most research and teaching positions in the life sciences, a minimum of a master's degree is required. For top-level positions of responsibility, a Ph.D. is preferred. 3. Those with a doctor's degree may begin a teaching position in this field with a salary of $7,000 to $9,000 a year. Those who enter a position in industry can expect to earn almost twice that much. Median salary in 1970 was about $14,000 a year. 4. Outlook should be good for those educationally qualified.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Using overhead transparencies, discuss the features and life cycles of representative flatworms and roundworms. 2. Show and discuss any of the films dealing with parasitism available from ESC Region 20. 3. Have interested students visit a local veterinarian to collect specimens of parasitic flatworms. 4. As a project have interested students make a poster size labeled anatomical drawing of a parasitic flatworm or roundworm to be displayed on the class bulletin board. CAREER: 1. Invite a parasitologist from a local college to class to discuss opportunities in this field 2. Have interested students write to the American Institute of Biological Sciences for further career information.	CURRICULUM: ESC REGION 20: Films: #8612 Flatworms - Platyhelminthes #8635 Parasitism - Parasitic Flatworms HARLANDALE AUDIO-VISUAL CENTER: Film: 16-502 Parasitism (flatworms) CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: Dictionary Of Occupational Titles Occupational Outlook Handbook WRITE TO: American Institute of Biological Sciences 3900 Wisconsin Avenue Washington, D.C. 20016	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
ANNELIDA -advances over flatworms and roundworms -polychaeta - ereis anatomy & and physiology -oligochaeta -lumbricus anatomy and physiology -hirudinea -leeches MOLLUSCA -pelecypoda -gastropoda -cephalopoda ECHINODERMATA	The student should be able to: 1. List and discuss at least three advances seen in the segmented worms which are not present in the flatworms and roundworms. 2. Label accurately anatomical drawings of each of the following being sure to give the function of each part: a) Neanthes-external anatomy b) Lumbricus terrestris-internal and external features c) clam d) squid e) starfish	CONCEPT: The annelids are one group of invertebrates studied by the invertebrate zoologist. OBJECTIVE: The student should be able to write a one page theme telling why he or she would or would not choose invertebrate zoology as a career.	INVERTEBRATE ZOOLOGIST 1. The invertebrate zoologist is concerned with the origins, interrelationships, classification, habits, distribution and life processes of animals without backbones. He often studies animals in their natural habitat and collects specimens for laboratory study. He dissects and examines specimens and uses various types of scientific equipment to carry out his experimental studies. The invertebrate zoologist may specialize in a particular species. 2. Graduate work in biological science is required if one hopes to have any measure of success. Those possessing the doctorate degree have the opportunity to move into administrative positions, supervising the research endeavors of other life scientists. 3. Beginning salaries for zoologists range anywhere from $8,000 to $14,000 depending upon educational background and scholastic achievement. 4. The coming decade looks bright for those possessing graduate training in this field.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do Laboratory Unit 28 entitled The Earthworm in their laboratory manuels 2. If specimens are available, have the students do a laboratory dissection of a preserved clam and preserved starfish. 3. Show and discuss any of the following films available from ESC Region 20: a.) Adaptive Radiation - The Mollusks b.) Echinoderms - Sea Stars and Their Relatives 4. Have interested students prepare a classified shell collection from specimens collected on a field trip to the coast. CAREER: 1. Invite an invertebrate zoologist from a local university to class to talk about his field. 2. Have interested students do a research report using the SRA Occuaptional Brief entitled Zoologists which is available from the school library or counselor's office.	CURRICULUM: ESC REGION 20: Films: #8586 Adaptive Radiation - The Mollusks #8099 Dissection and Anatomy of the Earthworm #8602 Echinoderms - Sea Stars and Their Relatives #8641 Segmentation - The Annelid Worms HARLANDALE AUDIO-VISUAL CENTER: Transparency: TP-11 Phylum Annelida, Oligochaeta CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #180 Zoologists Dictionary Of Occupational Titles Occupational Outlook Handbook WRITE TO: American Institute of Biological Sciences 3900 Wisconsin Avenue, N.W. Washington, D.C. 20016	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
ARTHROPODA -general anatomical features -five classes -crustacea -millipedes -centepedes -arachnids -insects -general survey of various orders of insects	The student should be able to: 1. Prepare, in tabular form, the arthropods and annelids. 2. Label correctly, with 90% accuracy, each of the following anatomical drawings: a) crayfish-internal and external anatomy b) grasshopper-internal and external anatomy 3. Characterize at least ten orders of insects and give at least one example of each order.	CONCEPT: Entomologists are concerned with the ecological and economic affects on insects on society. OBJECTIVE: The student should be able to state orally at least two reasons why he or she would or would not like to be an entomologist.	ENTOMOLOGIST 1. The entomologist studies primarily insects and their relationships to plant and animal life. He classifies the enormous number of different kinds of insects and seeks to control the harmful varieties through the use of chemicals or other methods. Some entomologists attempt to develop ways to encourage the growth and distribution of beneficial varieties. 2. Young people seeking professional status in the field of entomology should plan on obtaining at least the master's degree and preferably the doctorate degree. Those without advanced training can expect to have limited promotional opportunities. This advanced training is also essential for many positions in research programs. 3. Average salaries in this field range from $14,000 to $16,000 a year. 4. Employment in the life sciences is expected to increase in the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do Laboratory Unit 29 entitled The Crayfish in their laboratroy manuals. 2. Show and discuss any of the films on Arthropods available from ESC Region 20 or the Harlandale Audio-Visual Center. 3. Have interested students prepare a poster size labeled anatomical drawing of any insect. 4. Have interested students make an insect collection of one order of insects, properly pinned, labeled and displayed. CAREER: 1. Invite an entomologist to class to talk about his career. 2. Have interested students write to the American Physiological Society for further career information.	CURRICULUM: ESC REGION 20: Films: #4919 The Big Green Caterpillar #4254 The Housefly and Its Control #8675 Insect Metamorphosis #2089 Insects and Spiders #8625 Jointed Legged Animals, The Arthropods #8645 Social Insects - The Honeybee HARLANDALE AUDIO-VISUAL CENTER: Films: 16-647 Language of the Bees 16-9 Ants 16-270 Flies and Mosquitoes: Their Life Cycle and Control 16-318 The Housefly 16-352 Insects 16-446 Introducing Insects (Butterflies, Beetles and Bugs) 16-447 Monarch Butterfly Story 16-106 The Mosquito 16-338 Story of Bees CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: Dictionary Of Occupational Titles Occupational Outlook Handbook WRITE TO: American Physiological Society 9650 Rockville Pike Bethesda, Maryland 20014	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
CHORDATA -distinctive features -Amphioxus -phylogenetic relationships in the animal kingdom -Aqnatha -Chondrichthyes -Osteichthyes	The student should be able to: 1. List at least three basic chordate characteristics. 2. Draw and label correctly an anatomical drawing of the internal anatomy of Amphioxus. 3. Draw a plausible phylogenetic tree of the animal kingdom and explain the relationships indicated by the tree. 4. Compare and contrast, in a written paper, the three classes of fishes.	CONCEPT: The multi-million dollar fishing industry is an important part of our economy. OBJECTIVE The student should be able to write a brief paragraph explaining why he would or would not enjoy being a professional fisherman.	FISHERMAN 1. Fishing is conducted on a commercial basis from coastal towns and cities throughout the country from Maine to California to Alaska. The type of work a fisherman does depends heavily upon the particular species being sought. It is an exiting occupation which is usually physically demanding but substantially rewarding. 2. Many of those entering the occupation learn the trade from their fathers or other relatives, since no formal educational qualifications are required. Some brief courses seamanship and related areas are offered as part of the curriculum in high schools and trade schools in some port cities. 3. Salaries for most fishermen are based on a share of the catch. Captains may earn as much as $15,000 a year with fishermen earning more than $10,000 during good years. 4. Commercial fishing is currently experiencing a decline but efforts are being made to revive this industry.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Using the lecture method, discuss the phylogenetic relationships in the animal kingdom. 2. Have the students prepare a bulletin board display of pictures of the various classes of fish. 3. As a laboratory exercise, have the students dissect a preserved perch. 4. As a special project have the students build a labeled clay model of the internal anatomy of a bony fish. 5. Show and discuss any of the following films available from ESC Region 20: a.) Fishes, Amphibians and Reptiles b.) What Is a Fish? c.) Fish Embryo - From Fertilization to Hatching CAREER: 1. Invite a commercial fisherman to class to talk about his work. 2. Have interested students arrange to interview a commercial fisherman. 3. Have interested students write to the Gloucester Master Mariners Association for further career information.	CURRICULUM: ESC REGION 20: Films: #2338 Embryonic Development of Fish #8611 Fish Embryo - From Fertilization to Hatching #2055 Fishes, Amphibians and Reptiles #8653 What Is a Fish? CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #49 Fishermen Dictionary of Occupational Titles Occupational Outlook Handbook WRITE TO: Gloucester Master Mariners Association 23 Duncan Street Gloucester, Massachusetts 01930	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
AMPHIBIA -urodela -anura -apoda REPTILIA -characteristics and advances AVES -general features	The student should be able to: 1. List at least three characteristics which distinguish amphibians from other vertebrates. 2. Name at least six body characteristics that allow a reptile to live entirely on land. 3. List at least eight features which distinguish birds from other vertebrates. 4. Discuss in a written paper, some of the more important evolutionary relationships between the amphibian, reptiles, and birds.	CONCEPT: Relationship of birds to the work of an ornithologist. OBJECTIVE: The student should be able to describe orally what it might be like to be an ornithologist.	ORNITHOLOGIST 1. The ornithologist is an animal scientist who specializes in the study of birds. He investigates and studies the relationships, habits, growth, development and general distribution of avian vertebrates. Usually the ornithologist likes to study birds in their natural habitat but sometimes specimens are studied in the laboratory. 2. Ornithologists, like other life scientists, must prepare themselves academically if they expect to achieve professional status in their field. Those with master's degrees and doctorates have a greater likelihood of entering top-level research or teaching positions. 3. Salaries for ornithologists vary according to the educational background and experience as well as the level of responsibility of the job. 4. Outlook for life scientists is expected to be favorable in the near future.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Using the lecture method, outline the distinctive features of amphibians, reptiles and birds. 2. Have the students do individual research reports on any of the amphibians, reptiles or birds that interest them. 3. Have interested students, as a specials project, prepare an anatomical model, using suitable materials, of a representative amphibian, reptile or bird. 4. Have the students prepare a labeled model of a bird or amphibian skeleton. 5. Show and discuss any of the films available from ESC Region 20. CAREER: 1. Invite an ornithologist from a local university to class to talk about his work. 2. Have interested students prepare a research paper dealing with the career of ornithologist using the Dictionary of Occupational Titles and information gained by interviewing an ornithologist.	CURRICULUM: ESC REGION 20: Films: #8568 Amphibian Embryo - Frog and Salamander #4070 Birds and Their Characteristics #8100 Dissection and Anatomy of the Frog #8676 Flight of Birds #8711 Frog Development - Fertilization to Hatching #8652 What Is a Bird? #8655 What Is a Reptile? #4774 What Is an Amphibian? HARLANDALE AUDIO-VISUAL CENTER: Films: 16-378 The Frog 16-376 Life Story of the Hummingbird CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: Dictionary Of Occupational Titles Occupational Outlook Handbook	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
MAMMALIA -familiar orders of mammals -insectivora -chiroptera -primates -carnivora -lagomorpha -Proboscidea -rodentia -perisso-dactyla -artio-dactyla -cetacea -vertebrate evolution	The student should be able to: 1. Characterize, in written tabular form, the ten more common orders of mammals and give at least two examples of each. 2. Outline schematically some of the basic features of the evolution of vertebrates and explain briefly the relationships between the seven classes.	CONCEPT: A distinguishing feature of mammals is hair or fur. The fur industry is a large and lucrative enterprise. OBJECTIVE: The student should be able to list at least one advantage and one disadvantage of being a fur farmer.	FUR FARMER 1. Fur farmers or fur ranchers, as they are sometimes called, raise such animals as mink, marten and rabbit in captivity for the purpose of producing quality pelts. Providing housing, food, water and a clean enviornment for his animals are his primary responsibilities. Extra attention must be paid to his animals during the breeding period. 2. Although there are no formal educational requirements, the potential fur farmer should plan on high school or college courses in animal husbandry as well as a working knowledge of biology, nutrition, genetics and zoology. The best way to acquire practical knowledge and experience is to work on an established fur farm for a while. 3. Quick profits are not the rule in the fur farming industry primarily because demand for furs varies widely. Earnings in this occupation also depend on the kind and number of animals being raised. 4. There has been a slight increase for furs in this country recently, but little expansion of this industry is expected.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Using the discussion method, briefly outline the features of the various orders of mammals. 2. Have the students prepare a written report dealing with vertebrate evolution. 3. Show and discuss the filmstrip entitled Age of Mammals available from the Harlandale Audio-Visual Center. CAREER: 1. Invite a fur farmer to class to discuss opportunities in this field. 2. Have interested students read the SRA Occupational Brief entitled Fur Farmers which is available from the school library or counselor's office. 3. Have interested students write to the EMBA Mink Breeders Association for further career information.	CURRICULUM: ESC REGION 20: Film: #8654 What Is a Mammal? HARLANDALE AUDIO-VISUAL CENTER: Filmstrip: Mi-113 Age of Mammals CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #45 Fur Farmers Dictionary Of Occupational Titles Occupational Outlook Handbook WRITE TO: EMBA Mink Breeders Association 3103 Lothrop Racine, Wisconsin	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
VERTEBRATE SYSTEMS -nutrition -foods -vitamins DIGESTIVE SYSTEM -mechanical aspects -chemical process -secretions and enzymes -absorption and utilization of nutrients	The student should be able to: 1. Name orally the six basic types of food and give the function of 2. Explain, in written form the chemical processes involved in the digestion of fats, proteins and carbohydrates. 3. Match correctly a list of digestive enzymes with their respective substrates. Example: salivary amylase-starches	CONCEPT: A knowledge of the various body systems, including a knowledge of nutrition, is essential to the licensed practical nurse. OBJECTIVE: The student should be able to write a paragraph describing some of the duties of a licensed practical nurse.	LICENSED PRACTICAL NURSE 1. The licensed practical nurse cares for ill, injured and convalescent people in the hospitals, clinics and private homes. Her duties include taking and recording temperatures; determining blood pressure and pulse rates; dressing wounds; giving enemas, alcohol rubs and massages; applying compresses, ice bags and hot water bottles; and observing patients. 2. Most practical nursing programs are twelve months long. During her training classwork in nursing theory, body structure and function, personal hygiene, nutrition, and the administration of drugs, is coordinated with her clinical work in the hospital. Important personal qualifications include a genuine concern for people and a strong desire to help them. 3. In 1968 the average annual salary for a licensed practical nurses was about $5,000 per year. 4. Because of the continued expansion of health facilities an increase in the number of licensed practical nurses is expected.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do Laboratory Exercise "D" entitled Digestion and Enzyme Action found in the appendix of this guide. 2. Have the students do Laboratory Exercise "E" entitled Action of an Enzyme on Milk found in the appendix of this guide. 3. Have the students do Laboratory Excercise "F" entitled Nutrition found in the appendix of this guide. 4. Have the students do Laboratory Unit 10 entitled Foods and Digestion in their laboratory manuals. 5. Have interested students create a poster size labeled anatomical drawing of the human digestive system. CAREER: 1. Invite a licensed practical nurse to class to discuss her training and her career. 2. Have interested students visit a local hospital to interview a licensed practical nurse. 3. Have interested students listen to the tapes about nursing which are available from the Harlandale Audio-Visual Center. 4. Have interested students write to the National Association for Practical Nurse Education for further career information.	CURRICULUM: ESC REGION 20: Films: #4048 Balance Your Diet for Health and Appearance #8539 Food, The Color of Life #8186 The Human Body - Nutrition and Metabolism #2085 Ingestion and Digestion HARLANDALE AUDIO-VISUAL CENTER: Films: 16-46 Digestion of Foods 16-62 Foods and Nutrition CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magentic tapes: MT-297 Licensed Practical Nurse MT-261 Your Future as a Licensed Practical Nurse Cassette tape: Cas T-45 Nurse SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #119 Licensed Practical Nurse WRITE TO: National Association for Practical Nurse Education 1465 Broadway New York, New York 10036	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
RESPIRATORY SYSTEM -organs in the respiratory system -lung structure and function -O_2 and CO_2 exchange -breathing mechanism -internal and external respiration	The student should be able to: 1. Define, in a short statement, each of the following terms: 1) bronchi 2) bronchioles 3) alveoli 4) internal respiration 5) external respiration 6) trachea 7) pleural membranes 2. Discuss, in a written paragraph, the transportation of oxygen and carbon dioxide in the blood. 3. Describe orally how the volume of the chest cavity changes during inspiration and exhalation.	CONCEPT: Relationship of breathing to the work of an inhalation therapist OBJECTIVE: The student should be able to prepare a written report describing the duties and activities of an inhalation therapist.	INHALATION THERAPIST 1. The inhalation therapist sets up and operates various types of devices such as iron lungs, oxygen tents, resuscitators and incubators to administer oxygen and other gases to patients. He regulates temperatures and flow of gases and visits inhalant patients daily. The inhalation therapist may also record the cost of materials, make out charge slips for patients and instruct trainees in the use and operation of inhalation equipment. 2. Nowadays the emphasis for therapists is on formal training in hospital schools of inhalation therapy. There are still some hospitals, however, that offer on-the-job training under medical supervision. 3. Earnings for experienced therapists ranged from $400 to $1,013 a month depending on experience and education, and location of the job. 4. A continuing need for inhalation therapists will be evident throughout the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Demonstrate and discuss the human respiratory system using a bell jar and balloon set-up. 2. Show and discuss the film entitled Mechanisms of Breathing available from the Harlandale Audio-Visual Center. 3. Have the students do individual written research reports dealing with the respiratory system. CAREER: 1. Invite an inhalation therapist from a local hospital to class to discuss his or her work. 2. Have interested students view the filmstrip entitled Inhalation Therapy Technician which is available from the Harlandale Audio-Visual Center. 3. Have interested students write to the American Registry of Inhalation Therapists for further career information.	CURRICULUM: HARLANDALE AUDIO-VISUAL CENTER: Film: 16-68 Mechanisms of Breathing CAREER: HARLANDALE AUDIO-VISUAL CENTER: Record w/filmstrip: CC-49 Inhalation Therapy Technician SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #388 Inhalation Therapists Dictionary Of Occupational Titles Occupational Outlook Handbook WRITE TO: American Registry of Inhalation Therapists Executive Director Strong Memorial Hospital 260 Crittender Bouldevard Rochester, New York 14642	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
CIRCULATORY SYSTEM -heart structure and function -blood vessels -composition of the blood -functions of the blood -blood groups and transfusions -clotting mechanism -antigens and antibodies -lymphatic enculation	The student should be able to: 1. Label correctly a diagram of the human heart and give the function of each part. 2. Trace orally the path of blood flowing through the heart. 3. List all of the components of the blood giving their origins and functions. 4. Describe accurately, in chemical terms, the clotting mechanism.	CONCEPT: The heart and circulatory system are the domain of the cardiologist. OBJECTIVE: The student should be able to state orally at least two reasons why he or she would or would not choose cardiology as a career.	CARDIOLOGIST 1. The cardiologist treats diseases of the heart and its functions. He examines patients for symptoms which might indicate heart disorders using the stethoscope, electrocardiograph, x-ray machine and various other medical devices. The cardiologist prescribes medications and recommends dietary changes as may be required. He also may perform surgical procedures and engage in research in an effort to understand cardiac disfunctions better. 2. After high school, if you plan on being a cardiologist, you will be required to complete the following: -four years of liberal arts study -four years of medical school -one-two years of internship -two-five years of residency 3. The net income of doctors providing patient care services ranged between $34,000 and $39,000 a year in 1970. Specialists in some areas earned more. 4. Excellent opportunities are anticipated for physicians through the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students make a full-page labeled anatomical drawing of the human heart. 2. Have the students do Laboratory Unit 11 entitled The Circulatory System in their laboratory manuals. 3. Have the students write to the local Heart Association for pamplets and brochures on the circulatory system. 4. Show and discuss any of the following films: a.) The Blood (ESC Region 20) b.) Dissection and Anatomy of the Mammalian Heart (ESC Region 20) c.) Heart and Circulation (HAVC) d.) Work of the Blood (HAVC) CAREER: 1. Invite a heart specialist to class to discuss his career. 2. Have interested students visit a medical school or hospital to interview a cardiologist. 3. Have interested students write a research paper dealing with a career in cardiology. 4. Have interested students write to the American Medical Association for further career information.	CURRICULUM: ESC REGION 20: Films: #8592 The Blood #8101 Dissection and Anatomy of the Mammalian Heart HARLANDALE AUDIO-VISUAL CENTER: Films: 16-80 Heart and Circulation 16-412 Story of the Bloodstream Reel I (Heart and Circulatory) 16-413 Story of the Bloodstream Reel II (Red Blood Cell) 16-345 Work of the Blood CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: Council on Medical Education American Medical Association 535 North Dearborn Street Chicago, Illinois 60610	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
EXCRETORY SYSTEM -general features -formation of urea -kidney structure and function -development of vertebrate kidneys	The student should be able to: 1. Distinguish, in a short statement between urea and urine and tell where each is formed. 2. Label correctly a schematic cross-sectional diagram of the kidney including the structure of a nephron and give the function of each part. 3. Define or discuss briefly, in a written paragraph, each of the following terms: a) pronephros b) mesonephoric duct c) opistonephric kidney d) metanaphric kidney	CONCEPT: A thorough knowledge of the excretory system is essential to the urologist. OBJECTIVE: The student should be able to describe orally the various activities and duties of a urologist.	UROLOGIST 1. The urologist diagnoses and treats diseases and disorders of the genito-urinary organs and tract. He examines patients, using the x-ray machine, fluoroscope and other equipment to help in determining the nature and extent of the disorder. Other medical devices he may use include the diathermy machine, catheter, cytoscope and the radiation emanation tube. The urologist may perform surgery as required as well as prescribe and administer medications to help combat infections. 2. Many years must be devoted to the study of medicine before a physician like the urologist is permitted to practice. Four years of college, four years of medical school and at least one year of internship is required plus a term of residency in order to complete work within a field of special competence. 3. Salaries of physicians vary according to the size and type of practice. In general, a physician can expect to earn anywhere from $24,000 to $35,000 a year or more. 4. There will undoubtedly be a continued demand for more doctors during the forseeable future.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do Laboratory Unit 12 entitled The Urogenital System of the Frog in their laboratory manuals. 2. Show and discuss the film entitled Work of the Kidneys available from the Harlandale Audio-Visual Center. 3. Have the students make a full-page labeled anatomical drawing of the human kidney along with a written description of its physiology. 4. Have the students do a laboratory excercise in which they perform a urinalysis. CAREER: 1. Invite a urologist from a local hospital to class to discuss his work. 2. Have interested students interview a urologist and write up a report of their findings.	CURRICULUM: ESC REGION 20: Film: #2011 Animal and the Environment HARLANDALE AUDIO-VISUAL CENTER: Film: 16-187 Work of the Kidneys CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Medical Association 535 North Dearborn Street Chicago, Illinois 60610	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
REPRODUCTIVE SYSTEM -male reproductive organs and their functions -female organs and their functions -ovulation -menstrual cycle -uterine development and changes during birth	The student should be able to: 1. Compare in tabular form the human male and female reproductive organs with those of a frog. 2. Label correctly a schematic diagram of the human male and female reproductive organs and give the function of each part. 3. Outline in written form what occurs during ovulation and the menstrual cycle. 4. Describe in a written paper the major aspects of uterine development and changes occurring during the birth of a child.	CONCEPT: Relationship of the reproductive system to the work of a gynecologist or obstetrician. OBJECTIVE: The student should be able to describe, in a short written paragraph, the duties and activities of a gynecologist.	GYNECOLOGIST (OBSTETRICIAN) 1. The gynecologist diagnoses and treats diseases of the female generative organs. He may care for patients throughout pregnancy and deliver babies as well. The gynecologist or obstetrician determines the need for modified diets and physical activities; periodically examines his patients, prescribing either medication or surgery; delivers infants, and cares for the mother for a prescribed period of time following childbirth. 2. The requirements for this occupation as well as the salary information and future employment outlook are very similar to those for the cardiologist and urologist found on the preceding pages.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do laboratory exercise "G" found in the appendix of this guide. 2. Show and discuss any of the following films: a.) Animal Reproduction (ESC Region 20) b.) Patterns of Reproduction (ESC Region 20) 3. Have the students do written research reports on any topic in this unit of interest to them. CAREER: 1. Invite a local obstetrician to class to discuss his career. 2. Have interested students interview a gynecologist concerning his occupation and write a report on their findings. 3. Have interested students listen to any of the tapes dealing with a career as a physician which are available from the	CURRICULUM: ESC REGION 20: Films: #8867 Animal Reproduction #2143 Patterns of Reproduction CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic tape: MT-296 Physicians Cassette tape: Cas T-37 Physicians SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #136 Physicians Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Medical Association 535 North Dearborn Street Chicago, Illinois 60610	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-embryonic development -comparison of egg and sperm cells -fertilization -cleavage and gastrulation -blastula development -germ layer development	The student should be able to: 1. List and compare in a written paper a human egg cell with a sperm. 2. Describe orally all of the events which occur during fertilization. 3. List each of the primary germ layers and name at least three organs or systems which develop from each layer.	CONCEPT: Relationship of embryonic development to the work of an embryologist OBJECTIVE: The student should be able to describe, in a written paragraph, the work of an embryologist.	EMBRYOLOGIST 1. An embryologist studies the development of an organism from the time of fertilization of the egg through the hatching process or gestation period. He investigates the physiological, biochemical and genetic processes that control development. He is interested in how and why this control is accomplished as well as in the causes of the various abnormalities which occur during embryonic development. 2. Graduates with a master's degree have a distinct advantage over those possessing only the bachelor's degree in secure professional positions in this field. Those with the doctorate degree usually have no difficulty in finding a research, teaching or administrative position in the life sciences. 3. Salaries for those having the Ph.D. in this field begin at about $11,905 or $14,192 a year. 4. A rather rapid increase in employment in the life sciences is expected throughout the next decade.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do Laboratory Unit 15 entitled Special Exercises in Vertebrate Development in their laboratory manuals. 2. Show and discuss the filmstrip entitled Development of Embryos available from the Harlandale Audio-Visual Center. 3. Show and discuss any of the films about development available from ESC Region 20. 4. Have the students prepare a full-page notebook drawing of a 48 hour chick embryo. CAREER: 1. Invite an embryologist from a local university to class to discuss his work. 2. Have interested students visit the embryology department of a local medical school and interview those working there.	CURRICULUM: ESC REGION 20: Films: #2012 An Animal Life Cycle #8595 Chick Embryo - From Primitive Streak to Hatching #2337 Embryonic Development-The Chick #2195 Theories of Development HARLANDALE AUDIO-VISUAL CENTER: Filmstrip: K-81 Development of Embryos CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: Occupational Outlook Handbook Dictionary Of Occupational Titles	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
NERVOUS SYSTEM -gross structure -neurons and their organization -reflex arc -nature of an impulse -impulse transmission -synapse	The student should be able to: 1. Define orally each of the following terms: a) neuron b) axon c) dendrite d) sensory neuron e) motor neuron f) neurilemma g) myelin sheath h) Schwann cells i) node of Ranvier 2. Explain orally what is meant by the reflex arc. 3. Describe, in a written paper, the physical and chemical nature of a nerve impulse. 4. Discuss orally at least two theories which have been proposed to explain the transmission of the	CONCEPT: Relationship of the structure and function of the nervous system to the work of a neurologist OBJECTIVE: The student should be able to write a short essay describing what it would be like to be a neurologist.	NEUROLOGIST 1. The neurologist diagnoses and treats organic diseases and other abnormalties of the nervous system. He may perform chemical, microscopic and bacteriological analyses of a patients blood or cerebrospinal fluid in order to determine the nature and extent of the disease present. The neurologist, being a medical specialist, also is licensed to prescribe and administer medication and drugs as well as to perform surgery when necessary. 2. The requirements for becoming a neurologist are the same as those for becoming a general practioner except for the additional years spent in residency. 3. Salaries for neurologists are comparable to those of other specialists in the medical field. 4. The outlook for physicians in general is expected to be quite favorable throughout the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM 1. Have the students do Laboratory Unit 17 entitled Some Functions of the Nervous System and Muscles in their 2. Have the students draw a schematic drawing of a reflex arc and provide a brief description of how it operates. 3. Show and discuss the film entitled Fundamentals of the Nervous System available from ESC Region 20. 4. Have each of the students prepare a written research report on any disease associated with the nervous system. CAREER: 1. Invite a neurologist to class to talk about opportunities in this field. 2. Have interested students interview a neurologist and report orally to the class about his findings.	CURRICULUM: ESC REGION 20: Film: #8617 Fundamentals of the Nervous System HARLANDALE AUDIO-VISUAL CENTER: Films: 16-423 Exploring the Human Nervous System 16-109 The Nervous System Trasnparency: TP-12 Nervous System CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: Occupational Outlook Handbook Dictionary Of Occupational Titles	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-central nervous system -spinal cord structure -functions of the spinal cord	The student should be able to: 1. Draw a schematic cross-sectional diagram of the spinal cord and correctly label all parts. 2. Define or discuss, in a short written statement each of the following: a) ascending tracts b) descending tracts c) associative neuron d) white matter e) gray matter f) sympathetic ganglion g) dura matter h) pia matter 3. List at least two basic functions of the spinal cord.	CONCEPT: A knowledge of the structure and functions of the spinal cord is essential to the chiropractor. OBJECTIVE: The student should be able to list at least one advantage and one disadvantage of becoming a chiropractor.	CHIROPRACTOR 1. The chiropractor adjusts the spinal column and other articulations of the body to prevent disease and correct abnormalities believed to be caused by an interference of the nervous system. He examines the patient using various medical devices and manipulates the spine or other involved area. 2. A license and success or a state board examination is required before one is admitted to practice. Upon completion of a four year chiropractic course one is allowed to take the licensing exam. 3. Chiropractors with some experience can earn an average of about $14,000 to $28,000 a year. 4. Employment opportunities for qualified chiropractors are expected to be favorable in the next decade. This is in spite of the fact that only a slight increase in services is expected.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Using an overhead transparency, discuss the structure and functions of the spinal cord. 2. Show and discuss the film entitled Spinal Column available from the Harlandale Audio-Visual Center. 3. Have the students do Laboratory Unit 16, part d, entitled The Spinal Nerves of the Frog and part e, entitled The Brain and Spinal Cord of the Frog. CAREER: 1. Invite a local chiropractor to class to discuss his training and his work. 2. Have interested students interview a local chiropractor. 3. Have interested students listen to the magnetic tape entitled Chiropractors which is available from the Harlandale Audio-Visual Center. 4. Have interested students write to the American Chiropractic Association for further career information.	CURRICULUM: HARLANDALE AUDIO-VISUAL CENTER: Films: 16-398 Human Body - Muscular System 16-298 Muscles and Bones of the Body 16-250 Spinal Column CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic tape: MT-299 Chiropractors SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #288 Chiropractors Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Chiropractors Association 2200 Grand Avenue P.O. Box 1535 Des Moines, Iowa 50306	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-brain structure and functions -cranial nerves -autonomic nervous system -sympathetic -parasympathetic	The student should be able to: 1. Compare, by means of a diagram, the frog brain and the human brain. 2. Name orally all twelve cranial nerves, indicate whether they are motor, sensory or mixed nerves and give the distribution of each nerve. 3. Compare, in a short statement, the action sympathetic and parasympathetic nerves.	CONCEPT: An anesthesiologist must be familiar with the structure and function of the brain and its cranial nerves. OBJECTIVE: The student should be able to describe orally the work of an anesthesiologist.	ANESTHESIOLOGIST 1. An anesthesiologist is a medical doctor who is a specialist in this field. In large hospitals there is usually an anesthesiologist in charge of the department with a number of nurse anesthesiologists working under him. He administers anesthetics, examines patients to determine the degree of risk and discusses the findings with the doctor in each case. The anesthesiologist must also institute remedial measures to counteract complications and record the type and amount of anesthetic administered. Often he may instruct medical students in the characteristics and methods of administering various types of anesthetics. 2. Requirements, salary and future outlook for this occupation are very similar to those of other doctors who are specialists in the medical field.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Using appropriate transparencies, lecture on the structure and functions of the human brain. 2. Show and discuss the film entitled Human Brain available from the Harlandale Audio-Visual Center. 3. Using transparencies available from the Harlandale Audio-Visual Center, lecture on the autonomic nervous system. CAREER: 1. Invite an anesthetist to class to discuss his or her work. 2. Have interested students interview an anesthetist in a local hospital. 3. Have interested students read the SRA Occupational Brief entitled Anesthetists. 4. Have interested students write to the American Association of Nurse Anesthetists for further career information.	CURRICULUM: HARLANDALE AUDIO-VISUAL CENTER: Films: 16-53 Endocrine Glands 16-204 Human Brain Filmstrip: K-78 How Hormones Control the Body Transparency: TP-13 Nervous System (Brain) TP-14 Nervous System, Brain, Median Section TP-16 Autonomic Nervous System CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #241 Anesthetists Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Association of Nurse Anesthetists 130 Randolph Street Chicago, Illinois 60601	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-behavior -unlearned and learned behavior -conditioned reflexes -habit and memory	The student should be able to: 1. Define, briefly but accurately, in a short statement what is meant by behavior. 2. Differentiate orally between learned and unlearned behavior and list an example of each. 3. Describe, in a written paragraph, a conditioned reflex. 4. Define orally each of the following: a) habit b) memory c) facilitation d) imprinting	CONCEPT: A knowledge of behavior, both normal and abnormal, is essential to the psychiatrist. OBJECTIVE: The student should be able to list at least two reasons why he or she would or would not like to become a psychiatrist.	PSYCHIATRIST 1. The psychiatrist is a medical doctor who, as a result of additional years of training and experience, has become a specialist in the diagnoses, treatment and prevention of mental disorders. He examines his patients to determine their general physical condition and performs other diagnostic tests in evaluating them. The psychiatrist determines the nature and extent of the disorder and formulates a program of treatment. 2. Psychiatrists usually attend a four year college and then a four year medical school after which they must complete a one year internship. The psychiatrist must spend an additional three years specializing in psychiatry in an approved training program. After two years of practice in a hospital or in private consultation, he is allowed to take the certifying examination administered by the American Board of Psychiatry and Neurology. 3. Psychiatrists in private practice may earn from $20,000 to $60,000 a year. Hospitals pay from $12,000 to $28,000 a year. 4. There is a very acute shortage of psychiatrists now and there will probably be an increasing demand for them in the future.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do laboratory exercise "H" found in the appendix of this guide. 2. Show and discuss the film entitled Mental Health available from the Harlandale Audio-Visual Center. 3. Have interested students prepare a written research report dealing with unlearned and learned behavior. CAREER: 1. Invite a psychiatrist to class to talk about his training and his work. 2. Have interested students interview a psychiatrist and report back to the class. 3. Have interested students read the SRA Occupational Brief entitled Psychiatrists which is available from the school library or counselor's office. 4. Have interested students write to the American Psychiatric Association for further career information.	CURRICULUM: HARLANDALE AUDIO-VISUAL CENTER: Films: 16-102 Mental Health CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #247 Psychiatrists Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Psychiatric Association 1700 18th Street, N.W. Washington, D.C. 20009	

TEACHER'S COMMENTS

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-sense organs -taste, touch and smell -anatomy of the eye -physiology of the eye -eye defects	The student should be able to: 1. Discuss, briefly in a short statement, each of the following: a) end-bulbs of Krause b) Ruffini's end organs c) Meissner's corpuscles d) Pacinian corpuscle e) chemoreceptors f) olfactory receptors 2. Draw a sketch of the human eye, label all parts and give the function of each. 3. Define orally each of the following terms: a) accommodation b) rhodopsin c) retinene d) astigmatism e) myopia f) hyperopia g) cataract	CONCEPT: An ophthalmologist must have a thorough understanding of the eye and vision. OBJECTIVE: The student should be able to discuss orally the work of an ophthalmologist.	OPHTHALMOLOGIST 1. An ophthalmologist diagnoses and treats diseases and injuries of the eyes. He examines the patient for symptoms of ocular disorder and determines the extent of abnormality using a variety of tests to determine the amount of vision loss. The ophthalmologist also prescribes and administers medications as well as performing surgery, when necessary. 2. Four years of medical school beyond the bachelor's degree plus two years as an intern are required. After internship a three or four year residency at an accredited hospital is necessary. All states require that the future ophthalmologists take the American Board of Ophthalmology examination. 3. Beginning ophthalmologists in private practice may be able to earn about $10,000 a year. After gaining some experience, he may earn anywhere between $25,000 and $50,000 a year. 4. There is a definite need for many more doctors in this specialty.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do Laboratory Unit 16, part a, entitled The Eye of the Sheep and part b, entitled Demonstration of the Blind Spot in their laboratroy manuals. 2. Show and discuss the film entitled Eyes and Vision available from ESC Region 20. 3. Have interested students as a special project, build a model of the eye along with a description of how it works. CAREER: 1. Invite an ophthalmologist to class to talk about opportunities in this field. 2. Have interested students interview a local ophthalmologist. 3. Have interested students write to the American Association of Ophthalmologist for further career information.	CURRICULUM: ESC REGION 20: Film: #4731 Eyes and Vision HARLANDALE AUDIO-VISUAL CENTER: Films: 16-182 The Ears and Hearing 16-186 Eyes and Their Care 16-114 The Nose CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #146 Ophthalmologists Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Association of Ophthalmology 1100 Seventeenth Street N.W. Washington, D.C. 20036	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
BACTERIA -bacteriological history -Koch's postulates and diseases -size and shapes of bacteria -bacteriological techniques -staining -culturing	The student should be able to: 1. Discuss, in three or four paragraphs, the work of the following scientists: a) Leeuwenhoek b) Hooke c) Pasteur d) Redi e) Spallanzani 2. State Koch's postulates and apply them in attempting to find the cause for a hypothetical disease suggested by the teacher. 3. List all of the steps in the gram stain.	CONCEPT: The prevention and treatment of disease is one of the concerns in operations of a modern hospital. OBJECTIVE: The student should be able to write a short paragraph on the duties and activities of a hospital administrator.	**HOSPITAL ADMINISTRATORS** 1. The hospital administrator coordinates all of the activities of the hospital. Usually he works under a board of trustees which may be elected or appointed. The hospital administrator directs and supervises the hospital staff in carrying out the policies of the board. He has a strong voice in the determination of the hospital's policies. 2. The accepted way of becoming a hospital administrator today is through the completion of four years in college and two years of graduate training. There are about 27 U.S. schools in the U.S. and Canada which offer this training. The new graduate usually begins as an assistant and advances after gaining 3. Salaries for hospital administrators depend to a large degree on the size and location of the hospital as well as the training and experience of the administrator. Full administrators may earn from $10,000.00 to $30,000.00 a year. 4. An increasing need for hospital administrators is predicted for the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do Laboratory Unit 19 entitled Bacteria in their laboratory manuals. 2. Show and discuss the film entitled Bacterial - Lab Study which is available from the Harlandale Audio-Visual Center. 3. Have the students prepare oral reports on any of the bacterial disease of interest to them. 4. Have the students culture several varieties of harmless bacteria and then make permanent stained slides of them. CAREER: 1. Invite a local hospital administrator to class to discuss his or her occupation. 2. Have interested students interview a hospital administrator and write a report on their findings. 3. Have interested students write to the American College of Hospital Administrators for further career information.	CURRICULUM: ESC REGION 20: Films: #2014 Bacteria #4465 Phagocytes - The Body's Defenders HARLANDALE AUDIO-VISUAL CENTER: Films: 16-354 Bacteria - Lab Study 16-551 Microbes and Their Control CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #235 Hospital Administrators Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American College of Hospital Administrators 840 North Lake Shore Drive Chicago, Illinois 60611	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-bacterial structure -reproduction in bacteria -bacterial classification -nutrition and metabolism in bacteria -nitrogen cycle and bacteria -carbon cycle	The student should be able to: 1. Define in a sentence or two, each of the following terms: a) autotrophic b) hetertrophic c) aerobic d) anaerobic e) capsule 2. Discuss, in a written exercise, at least two factors which retard the rate of growth and multiplication of bacteria in a culture. 3. Draw a schematic drawing with an accompanying explanation of each of the following: a) nitrogen cycle b) carbon cycle	CONCEPT: The bacteriologist must have a thorough knowledge of microorganisms. OBJECTIVE: The student should be able to describe, in a paragraph, the work of a bacteriologist.	BACTERIOLOGIST 1. The bacteriologist studies the growth, structure and development of bacteria and other microorganisms. He isolates and makes cultures of significant bacteria using prescribed media and attempts to identify them microscopically. The bacteriologist also observes the action of microorganisms upon the living tissues of plants, on higher animals, and on dead organic matter. 2. A bachelor's degree in bacteriology may be adequate preparation for some beginning jobs in this field, but advancement without graduate graining is generally limited. Other personal graduates include the ability to work independently or as part of a team, the ability to express oneself and an inquiring mind. 3. Starting salaries for bacteriologists depend upon the degrees earned. Those with a bachelor's degree could begin at $6,548.00 or $8,098.00 depending on their college record. Those with a master's degree could begin at about $9,851. and those posessing the Ph.D could begin at $11,905. a year. 4. Bacteriologists holding an advanced degree should have no difficulty in securing a position.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Show and discuss the filmstrip entitled Nature's Cycles available from the Harlandale Audio-Visual Center. 2. Show and discuss the film entitled Bacteria - Friend and Foe available from the Harlandale Audio-Visual Center. 3. Have the students write to the local department of health for information about bacterial growth in water supplies and foods. CAREER: 1. Invite a bacteriologist from a local college or city water department to class to talk about his or her work. 2. Have interested students read the SRA Occupational Brief entitled Microbiologists which is available from the school library or counselor's office. 3. Have interested students write to the American Society for Microbiology for further career information.	CURRICULUM: HARLANDALE AUDIO-VISUAL CENTER: Films: 16-16 Bacteria - Friend and Foe 16-375 Microscopic Life in the Soil Filmstrip: K-80 Nature's Cycles (Oxygen/Carbon dioxide) CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #338 Microbiologists Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Society for Microbiology 115 Huron View Blvd. Ana Arbor, Michigan	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
VIRUSES -classification of viruses -bacteriophages -lysogeny -Rickettsiae	The student should be able to: 1. Define or discuss in a sentence or two each of the following: a) plague b) virulent c) temperate phage d) lysogenic e) Paschen bodies 2. Diagram and explain the lytic cycle and lysogeny 3. Discuss, in two or three paragraphs, the importance of the Rickettsiae.	CONCEPT: Viral diseases are one type studied extensively by the pathologist. OBJECTIVE: The student should be able to list at least three duties or responsibilities of a pathologist.	PATHOLOGIST 1. The pathologist is concerned with the nature, cause and development of diseases. He studies the structural and functional changes caused by diseases and diagnoses, from body fluids and other specimens the presence and stage of a disease. The pathologist is a consultant to other medical practitioners and frequently performs autopsies for them. 2. A student wishing to become a pathologist must go through twelve years of post-high school training before being certified as a pathologist. His training is as any other medical doctor. 3. Earnings for newly certified pathologists vary according to location. Most pathologists earn at least $20,000. a year, and some earn as high as $50,000. 4. The need for qualified pathologists is becoming more acute each year. Some rural hospitals do not even have part-time services of a pathologist available.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Show and discuss the film entitled Viruses available from ESC Region 20. 2. Have interested students build models of various viruses using suitable materials. 3. Have interested students do a written research paper on any aspect of virology which is of interest to them. CAREER: 1. Invite a pathologist from a local hospital to class to discuss his or her training. 2. Have interested students interview a pathologist at a local hospital. 3. Have interested students write to the American Society of Clinical Pathologists for further career information.	CURRICULUM: ESC REGION 20: Film: #2209 Viruses CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #386 Pathologists Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Society of Clincial Pathologists 2100 West Harrison Street Chicago, Illinois 60612	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
LOWER PLANTS -algae and fungi -types and classification -byrophytes -mosses -liverworts -alternation of generations	The student should be able to: 1. List the major types of algae and describe each briefly in a short paragraph. 2. Outline the life cycle of each of the following: a) wheat rust b) common moss c) a common liverwort 3. Describe orally each of the three common forms of lichens. 4. Explain orally the economic value of the bryophytes.	CONCEPT: The lower plants constitute a major group of plants which are of importance to the botanist. OBJECTIVE: The student should be able to describe orally the primary concerns of the botanist.	BOTANIST 1. A botanist studies the development physiology, heredity, anatomy and distribution of plants. He investigates the nature and behavior of chromosomes; plant cells and tissues using microscopes, special staining techniques and scientific equipment. The botanist is also concerned with the effect of rainfall, temperature, climate and soil on the growth of plants. 2. Those wishing to achieve professional status in this field should plan on obtaining at least a master's degree. In addition, a botanist should have a genuine love of plants; imagination and curiosity; the ability to conduct complicated experiments; the patience to keep detailed records; and the ability to work well with others. 3. Beginning salaries for botanists can vary anywhere from $6,000 to $9,000 a year depending on the type of position the geographical location and the degrees earned. 4. Opportunities in the biological sciences are expected to increase substantially during the 1970's and a greater demand for botanists at all levels is predicted.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do any of the following Laboratory Units in their laboratory manuals: a.) Unit 18 - Algae b.) Unit 20 - Yeasts and Molds c.) Unite 21 - Mosses and Liverworts 2. Have the students do laboratory exercise "I" found in the appendix of this guide. 3. Show and discuss any of the films available from ESC Region 20 and the Harlandale Audio-Visual Center. CAREER: 1. Invite a botanist from a local college to class to discuss opportunities in this field. 2. Have interested students read the SRA Occupational Brief entitled Botanists which is available from the school library or counselor's office. 3. Have interested students write to the Botanical Society of America for further career information.	CURRICULUM: ESC REGION 20: Films: #2022 The Bryophytes #8618 Fungi #2071 The Higher Fungi #8633 Origin of Land Plants-Liverworts and Mosses #8643 Simple Plants - The Algae HARLANDALE AUDIO-VISUAL CENTER: Films: 16-246 Carnivorious Plants 16-218 Fungus Plants 16-95 Life of a Plant 16-543 Origin of Land Plants Liverworts and Mosses Transparency: TP-1 Algae- Reproduction, Ulothrix TP-2 Fungi - Life Cycle of Wheat Rust TP-3 Moss - Musci CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #294 Botanists Dictionary Of Occupational Titles Occupational Outlook Handbook WRITE TO: Botanical Society of America, Inc. c/o Department of Botany Rutgers University	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
TRACHEOPHYTES -ferns -types and life cycles -gymnosperms -pine life cycle	The student should be able to: 1. Outline schematically each of the following life cycles: a. Lycopodium b. Selaginella c. Polypodium 2. Compare orally the sprophythe of a mass and a fern and indicate how the fern is more advanced. 3. Define, in a written sentence, each of the following: a. antheridia b. archegonia c. protonema d. thallus e. frond f. sorus g. sporanguim h. prothallus i. rhizome	CONCEPT: Masses and ferns are among the plants sometimes used in landscaping. OBJECTIVE: The student should be able to list at least three duties or activities of a groundskeeper or gardener.	GROUNDSKEEPER OR GARDENERS 1. Gardeners and groundskeepers are responsible for gardens, lawns, shrubbery and trees in such places as private estates, cemeteries, schools, golf courses, and other institutions with extensive property. They often select seeds and bulbs; make transplants and cuttings; water plants and apply suitable fertilizers; and trim and prune plants, shrubs and trees when needed. The gardener uses a variety of tools and implements in this work and since his duties change with the seasons, there is little chance of his job becoming monotonous. 2. Formal education is of little concern to many employers who are generally satisfied with an ability to read and write. Some practical gardening experience is desirable as are gardening and landscaping courses from vocational and trade schools. 3. Earnings in this occupation vary considerably according to the particular job and the locality. Salaries can range from under $2.00 an hour for part-time work to as high as 780 a month for supervisors. 4. Future prospects for this occupation are not outstanding but talented individuals should have no difficulty in securing a position which will provide a satisfying living.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do Laboratory Unit 22 entitled Ferns in their laboratory manuals. 2. Show and discuss the film entitled Evolution of Vascular Plants - Fern available from the Harlandale Audio-Visual Center. 3. Have the students do laboratory Unit 23 entitled The Pine in their laboratory manuals. CAREER: 1. Invite a gardener or groundskeeper to class to talk about his work. 2. Have interested students read the SRA Occupational Brief entitled Garderners and Groundskeepers which is available from the school library or counselor's office. 3. Have interested students write to the National Association of Gardeners for further career information.	CURRICULUM: ESC REGION 20: Film: #8623 Gymnosperms HARLANDALE AUDIO-VISUAL CENTER: Films: 16-546 Evolution of Vascular Plants - Fern 16-544 Gymnosperms Transparency: TP-4 Fern - Filicineae TP-5 Vascular Plants CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #330 Gardeners and Groundskeepers Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: National Association of Gardeners 194 Old Country Road Mineola, New York 11501	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
FLOWING PLANTS -types of flowers -flower parts -pollination -life cycle of a flowing plant -seeds -germination	The student should be able to: 1. Label correctly a diagram of a longitudinal section of a complete flower. 2. Sketch and explain the life cycle of a flowering plant indicating both the gametophyte and sporophyte phases. 3. Define or discuss in a sentence or two each of the following terms: a. endosperm b. cotyledons c. hypocotyl d. epicotyl e. radicle	CONCEPT: Relationship of flowering plants and trees to the work of a tree expert or tree surgeon. OBJECTIVE: The student should be able to list at least three duties of a tree surgeon.	TREE EXPERT 1. A tree expert or tree surgeon, as he is sometimes called, cares for and maintains ornamental trees and shrubs. His activities include pruning trees, correcting defects, spraying with insecticides and fungicides, fertilizing, and moving large trees from one location to another. 2. A tree surgeon must have a special knowledge of trees as well as the skills required to do the work. Training can be obtained in trade schools, schools of agriculture and forestry or from some large tree companies. One way to get started is to apply to a tree-care company directly. 3. Earnings for employees who completed their apprenticeship range from $90 to $100 a week while foremen earn up to $135 a week. Supervisors and district managers can earn from $10,000 to $14,000 a year. 4. With population increasing as it is, there will probably be an increase in the need for tree experts or tree surgeons.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do Laboratory Unit 24 entitled Reproduction in the Flowering Plants in their laboratory manuals. 2. Show and discuss any of the films available from ESC Region 20 or the Harlandale Audio-Visual Center. 3. Have the students make a collection of leaves after researching the proper method for preserving and pressing specimens. 4. Have the students do any of the following Laboratory Units: a.) Unit 5 - Leaves b.) Unit 6 - Roots c.) Unit 7 - Stems CAREER: 1. Invite a tree surgeon to class to discuss his work. 2. Have interested students write to the American Association of Nurserymen for further career information.	CURRICULUM: ESC REGION 20: Films: #8589 Angiosperms - The Flowering Plants #2336 Colour of Life #8613 Flowers at Work #8622 Growth of Plants #2150 Plant Reproduction #4470 Plant Tropisms and Other Movements #8640 Seed Germination #2175 Seeds and Germination HARLANDALE AUDIO-VISUAL CENTER: Films: 16-545 Angiosperms 16-611 Flowers: Structure and Function 16-315 Growth of Seeds 16-94 Leaves Transparency: TP-6 Angiosperms (Monocot and Dicot) TP-7 Angiosperms (Stem Structure) TP-8 Stem Structure TP-10 Flower Fertilization CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #190 Tree Expert Occupational Outlook Handbook WRITE TO: American Association of Nurserymen 835 Southern Building	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-development of fruits -classification of fruits -dry fruits -fleshy fruits -phylogenetic relationships in plants	The student should be able to: 1. Discuss, in two or three paragraphs, the general development of fruits from fertilization to the production of the seed. 2. Contrast, in a short written statement, a simple fruit and an aggregate fruit; a dehiscent fruit and an indehiscent fruit. 3. Sketch an outline of a phylogenetic tree of plants and explain orally the relationships between the groups of plants.	CONCEPT: Relationship of the various types of fruits to the work of a fruit grower. OBJECTIVE: The student should be able to list at least two advantages and two disadvantages of being a fruit grower.	FRUIT GROWER 1. Fruit growing in the United States is a $1.5 billion dollar industry at the farm level. Fruit is grown in all fifty states and employment in fruit farms includes about 150,000 full-time workers. The duties of a fruit farmer include preparing the land, planting new fruit trees, pruning existing plants, spraying trees and harvesting the crop at the proper time. The final task of the grower is the marketing of his product by selling it outright to a shipper or paying a skipper a fee to handle the marketing for him. 2. To begin in this occupation requires a substantically amount capital outlay in addition to training in horticulture is also very desirable. 3. Net income on a fruit farm depends partly on whether the farmer only grows fruit or combines fruit growing with other operations on his farm. Income is usually about one-third of the total amount received from the marketing of the product. 4. There are currently fewer opportunities for beginners than there were 25 years ago due to the decline in the number of farms and an increase in their size.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have each of the students prepare a painted poster depicting the different types of fruits. A prize can be offered for the best presentation. 2. Have the students do a research report on plant phylogeny. CAREER: 1. Invite a local fruit grower to class to talk about his work. 2. Have interested students visit a fruit farm and interview the workers there. 3. Have interested students read the SRA Occupational Brief entitled Fruit Grower which is available from the school library or counselor's office. 4. Have interested students write to the United Fresh Fruit and Vegetable Association for further career information.	CURRICULUM: ESC REGION 20: Film: #2042 Diversity In Form and Size CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #44 Fruit Grower Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: United Fresh Fruit and Vegetable Association 777 Fourteenth Street, N.W. Washington, D.C. 20005	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
HEREDITY -Mendel and his experiments -genetic terminology -chromosomes and genes -independent assortment -simple crosses -test cross -multiple alleles	The student should be able to: 1. State each of Mendel's laws and explain them in a short written statement. 2. Define accurately in a sentence or two, each of the following: a. homozygones b. heterozyons c. diploid d. haploid e. dominant f. recessive g. allele h. genotype i. phenotype 3. Solve correctly, at least ten problems dealing with simple genetic crosses and multiple alleles. 4. Explain orally how a test cross is used to determine the genotype	CONCEPT: Heredity and breeding play a significant role in the work of a cattleman. OBJECTIVE: The student should be able to list at least three duties or responsibilities of a cattleman.	CATTLEMEN 1. The cattleman's primary concern is the breeding and raising of livestock. He fences pens and pastures, supplies his cattle with feed, maintains feed weight and pedigree records and determines the most favorable months for calving. Some of his other duties include branding, castrating and tatooing calves to improve or mark them according to customs, laws and practices of the local area. 2. Those being raised on a farm or ranch naturally have a distinct advantage in obtaining the valuable experience necessary for becoming a successful cattleman. College preparation in range management, animal science and business management are also very desirable. 3. Earnings in this occupation vary considerably from year to year depending on the size of the herd, the size and location of the herd and the business management ability of the cattleman. 4. The outlook for cattlemen in the near future appears quite favorable based on the fact that beef consumption will increase as the population increases.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the student do any of the following Laboratory Units in their laboratory manuals: a.) Unit 30 - Introduction to Genetic Studies b.) Unit 31 - Problems in Genetics; Human Genetics; Corn Genetics 2. Show and discuss any of the following films available from ESC Region 20: a.) Genes and Chromosomes b.) Laws of Heredity c.) The Science of Genetics 3. Have the students do laboratory exercise "J" entitled Genetics found in the appendix of this guide. CAREER: 1. Invite a local cattleman to class to discuss his career. 2. Have interested students interview a cattleman and orally report back to the class on their findings. 3. Have interested students write to the American Hereford Association for further career information.	CURRICULUM: ESC REGION 20: Films: #2061 Genes and Chromosomes #8628 Laws of Heredity #2173 The Science of Genetics HARLANDALE AUDIO-VISUAL CENTER: Filmstrip: K-77 Heredity CAREER: ESC REGION 20: Film: #2372 Our Changing Way of Life - Cattleman - A Rancher's Story SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #42 Cattlemen Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Hereford Association Hereford Drive Kansas City, Missouri 64105	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-sex chromosomes and linkage -crossing-over -chromosome maps -lethal genes -ploidy	The student should be able to: 1. Solve correctly at least five genetics problems involving sex-linked genes. 2. Describe, in a short paragraph, what is meant by crossing-over and explain the significance of this phenomenon. 3. Explain orally how chromosome maps are made. 4. Define and illustrate with a sketch, each of the following: a. deletion b. inversion c. duplication d. translocation	CONCEPT: The study of genetics has led to the improvement of many animal species including poultry. OBJECTIVE: The student should be able to write at least two paragraphs describing what it would be like to be a poultry farmer.	POULTRYMAN 1. The poultryman raises chickens, turkeys, and other poultry for sale as meat. He selects and purchases stock and cares for them by feeding and housing them. He also sprays his poultry houses with disinfectants periodically and vaccinate his stock against diseases. The poultryman must continually help feed and production records, hire and supervise workers and arrange for the sale of his poultry. 2. Although there are not strict educational requirements, a prospective poultry farmer should take all the high school courses he can in the sciences, math and English. Some college would be helpful but if it is out of the question obtain literature on this occupation from various sources. Aside from the educational qualifications, a poultry farmer should be in good health and not afraid of hard work. 3. Average net salaries in this occupation range from $6,000 to $9,000 a year. Some experienced poultrymen may earn as much as $20,000 annually. 4. A serious shortage of trained personnel in this field is currently being experienced and there is a strong demand for graduates with backgrounds in poultry.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do laboratory exercise "K" entitled Heredity and Natural Selection: A Model System found in the appendix of this guide. 2. Show and discuss the film entitled Inheritance in Man available from ESC Region 20. 3. Have the students prepare pedigrees of their families using as many traits possible. 4. Drill the students in the solving of genetics problems by giving them sets of mimeographed problems to solve. CAREER: 1. Invite a poultryman to class to discuss opportunities in this occupation. 2. Have interested students read the SRA Occupational Brief entitled Poultrymen which is available from the school library or counselor's office. 3. Have interested students write to the Poultry and Egg National Board for further information.	CURRICULUM: ESC REGION 20: Film: #2086 Inheritance In Man CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #47 Poultrymen Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: Poultry and Egg National Board 8 South Michigan Avenue Chicago, Illinois 60603	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-human inheritance -heredity and environment -molecular genetics -DNA and replication -metabolic pathways -protein synthesis	The student should be able to: 1. Solve correctly at least five problems dealing with human inheritance. 2. Define or discuss, in a short statement each of the following: a. phenylketonuria b. galactosemia c. primary blocks d. secondary blocks e. density gradient centrifugation f. transormation 3. Explain, in a written paragraph, how DNA replication is accomplished. 4. Explain orally, using a schematic diagram, the process of protein synthesis.	CONCEPT: Relationship of the laws of heredity to the work of a genetic counselor OBJECTIVE: The student should be able to list at least two reasons why he or she would or would not like to be a genetic counselor.	GENETIC COUNSELOR 1. The genetic counselor investigates the origin, transmission and development of hereditary abnormalities and attempts to help prevent their occurrence by advising married couples in such matters. 2. A person contemplating genetic counseling as a career should take all the math and science courses available to him in high school. Graduate training in genetics and the attainment of at least a master's degree is essential. The Ph.D. degree is preferable especially if one enters the teaching aspect of this occupation and expects to achieve a top-level position. 3. Salaries in this field depend upon the type of degree or degrees earned. Persons with a bachelor's could begin at $6,548 or $8,098; those with a master's degree could start at $8,098 or $9,881, and those with a Ph.D. degree could begin at $11,905 or $14,192 a year. 4. Employment opportunities in this field should be favorable throughout the next decade.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Show and discuss the film entitled Cracking the Code of Life available from ESC Region 20. 2. Lecture on protein synthesis using the appropriate filmstrip from the Harlandale Audio-Visual Center. 3. Have interested students do a written research paper on the effects of heredity and environment on the development of an organism. CAREER: 1. Invite a genetic counselor to class to talk about his work. 2. Have interested students do a research paper dealing with genetic counseling.	CURRICULUM: ESC REGION 20: #8685 Cracking the Code of Life #8619 Gene Action HARLANDALE AUDIO-VISUAL CENTER: Filmstrip: K-85 RNA and Protein Synthesis CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: Dictionary Of Occupational Titles Occupational Outlook Handbook	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
EVOLUTION -evidence from: -comparative anatomy -developmental biology -biochemistry -genetics -palenotology -development of man	The student should be able to: 1. List at least one evidence of evolution from each of the following areas: a. comparative anatomy b. developmental biology c. biochemistry d. genetics e. palenotolgy 2. Define or discuss, in a sentence or two, each of the following: a. divergent evolution b. convergent evolution c. analogous structures d. recapitulation 3. Discuss, in a written paper, the evolution of primates naming and characterizing all of the important human and subhuman fossils.	CONCEPT: A basic knowledge of evolution is essential for those wishing to become museum workers. OBJECTIVE: The student should be able to describe, in two or three paragraphs, the work of a museum technician.	MUSEUM TECHNICIAN 1. A museum technician prepares specimens for collections and exhibits. He cleans fossil specimens, brushes preservatives on them and frequently molds and restores skeletal parts. Often he reconstructs fragmented artifacts and makes substitute pieces. The museum technician also maintains the museum files as well as installs, arranges, and exhibits materials. 2. No standardized training course is available but some universities offer courses in certain aspects of museum work, combined with practical experience. Technicians on the curatorial staff must be craftsmen in various mediums and be interested in art, history, science and education. This should also be capable of working on their own without supervision. 3. Salaries for museum technicians range from $4,900 to $7,100 a year depending on the size and location of the institution. Assistant curators may earn from $4,200 to $8,000. 4. Due to an increasing population and more leisure time, there has been substantial growth in the number of museums being built. Opportunities should be favorable in the near future.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do Laboratory Unit 35 entitled Some Aspects of Evolution in their laboratory manuals. 2. Have the students view the film entitled Nature of Diversity and write a brief synopsis of it. CAREER: 1. Invite a museum worker to class to talk about his occupation. 2. Have interested students visit a local museum to interview workers there. 3. Have interested students read the SRA Occupational Brief entitled Museum Workers which is available from the school library or counselor's office. 4. Have interested students write to the American Association of Museums for further career information.	CURRICULUM: ESC REGION 20: Films: #8794 Cave Dwellers of the Old Stone Age #2367 Dr. Leakey and the Dawn of Man #2125 Nature of Diversity CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #219 Museum Workers Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Association of Museums 2306 Massachusetts Aven NW Washington, D.C. 20008	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-mechanism of evolution -Lamarck and Darwin -natural selection -populations and the Hardy-Weisberg law -mutations -genetic drift and migration	The student should be able to: 1. Describe at least two explanations which have been proposed for the origin of the different species of organisms 2. Explain orally the Hardy-Weinberg law. 3. Define, in a short statement, each of the following: a. genetic drift b. speciation c. isolation d. polyploidy	CONCEPT: A physical anthropologist must have a sound knowledge of evolution, population dynamics and genetic drift. OBJECTIVE: The student should be able to list at least two duties or activities of a physical anthropologist.	PHYSICAL ANTHROPOLOGIST 1. The physical anthropologist studies the causes of human differences and their effects on the culture, heredity and environment of the human race. He is interested in human fossils and their meaning in terms of human evolution. The physical anthropologist studies variations and physical attributes of exisiting human types and investigates growth patterns, sexual differences and aging phenomona of present and past human groups. 2. Entrance into this profession usually requires a graduate degree, preferably the Ph.D. degree. Languages are very important and a major in modern language while in college should be considered. A belief in cultural relativism - the idea that there can be value in other cultures besides one's own - is essential to an anthropologist. An aptitude for getting along under just about any circumstances is also essential. 3. Beginning salaries for the anthropologist range from $8,000 to $10,000 provided he has his doctorate. One with experience and some years in the field may earn about $30,000. 4. Opportunities for the prospective anthropologist are favorable due to the small number who enter the field.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do Laboratory Unit 36 (part I) entitled Ecological Factors and Animal Distribution found in their laboratory manuals. 2. Show and discuss any of the films on this topic available from ESC Region 20. 3. Have interested students do a research paper on genetic drift and mutations using such sources as Scientific America. CAREER: 1. Invite an anthropologist from a local university to class to discuss his career. 2. Have interested students read the SRA Occupational Brief entitled Anthropologists which is available from the school library or counselor's office. 3. Have interested students write to the American Anthropological Association for further career information.	CURRICULUM: ESC REGION 20: Films: #8598 Distribution of Plants and Animals #2115 The Mystery of Life #8632 Natural Selection #2341 Natural Selection and Adaptation #8637 Population Ecology #2151 Population Ecology #2186 Species - Stability and Change #2188 Standing Room Only CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic tape: MT-310 Anthropologists SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #197 Anthropologists Occupational Outlook Handbook WRITE TO: American Anthropological Association 3700 Massachusetts Avenue NW Washington, D.C. 20016	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
THE ENVIRONMENT -physical aspects -water, light, temperature, etc. -biotic factors -cycles of elements -food chains -types of communities -succession -balance of nature and conservation	The student should be able to: 1. Define orally each of the following terms: a. hydrophytes b. mesophytes c. xerophytes d. photoperiodism e. hibernation f. estivation 2. Explain briefly by means of a flow chart at least two of the following: a. CO_2 cycle b. O_2 cycle c. N_2 cycle d. water cycle 3. Describe, in writing, at least one food chain. 4. State orally how the balance of nature is related to conservation.	CONCEPT: The environment is one of the primary concerns of a wildlife manager. OBJECTIVE: The student should be able to list at least three activities of a wildlife manager as well as at least two reasons why he or she would or would not consider this occupation as a life's	WILDLIFE MANAGER 1. The wildlife manager is concerned with providing wildlife resources for public enjoyment while making certain that conservation practices are in force. Some of his duties include the prevention of trespassing especially during hunting and nesting seasons; the restocking of lakes and streams; and the prevention of diseases and forest fires in his area. Part of his day includes office work including the preparation of regular reports on the conditions in the area. 2. A bachelor's degree with a major in biology, zoology or wildlife management is required for federal employment. Most state agencies require a degree as well. Government employment in this field requires a minimum age of 18, citizenship and the successful completion of a physical and written examination. Good health and physical stamina are also essential requirements. 3. Salaries for beginners in this field are about $500 a month. Those with some experience earn from $10,000 to $15,000 a year in addition to paid vacations, sick leave, group life and health insurance and other fringe benefits. 4. The demand for trained personnel in wildlife management is expected to grow in the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students prepare a bulletin board of newspaper and magazine pictures and articles dealing with ecology. 2. Show and discuss any of the following filmstrips available from the Harlandale Audio-Visual Center: a.) Biological Communities b.) Giving Our Wildlife a Chance 3. Have the students write to the Texas Wildlife Commission for pamphlets and brochures on conservation. CAREER: 1. Invite a wildlife manager to class to talk about his training and his work. 2. Have interested students read SRA Occupational Brief #149 entitled Wildlife Managers and write a brief report on it. 3. Have interested students write to the Bureau of Sport Fisheries and Wildlife for further career information.	CURRICULM: ESC REGION 20: Films: #4931 Animal Predators and the Balance of Nature #4725 The Community #4125 Conserving Our Forests Today #4130 Conserving Our Water Resources #8624 High Arctic Brome #8702 Hot Dry Desert #4763 The Physical Environment #4471 Plant - Animal Communities - Physical Environment #8647 Succession - From Sand Dune to Forest HARLANDALE AUDIO-VISUAL CENTER: Film: 16-291 What Is Ecology? Filmstrips: K-84 Biological Communities B-76 Giving Our Wildlife a Chance CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #149 Wildlife Managers WRITE TO: Bureau of Sport Fisheries and Wildlife Fish and Wildlife Service U. S. Department of the Interior Washington, D.C. 20240	

APPENDIX

The following laboratory exercises were drawn from a publication of the Texas Education Agency entitled Life Science-An Activity Guide (Bulletin #723-1972). Since publications of the Agency are not copyrighted, any of the exercises may be duplicated for classroom use.

RESPIRATION

Exercise "A"

Objectives

At the end of this activity the student should be able to

- Describe the need for oxygen by animals
- Measure the rate of oxygen consumption by an animal
- Interpret these data to support hypotheses

Materials

A small animal, such as a mouse, frog, or grasshopper
Glass container with a wide mouth for a one-hole stopper (The container should be large enough for the animal.)
Tubing (glass or plastic) to connect the one-hole stopper to the manometer
Manometer (or U tube of glass containing water with food coloring)
Small cup or vial
Sodium hydroxide (NaOH) pellets (or fresh dry lye) to fill the vial
Thread or string to hold small vial inside the container near the mouth
Ruler
Clock or watch

How to Get Started

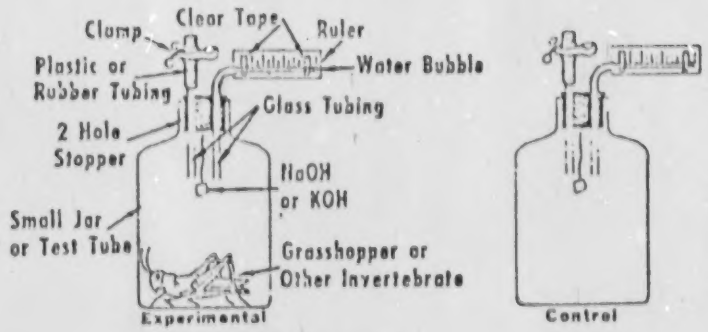
- Why do we need air to breathe?
- What happens if we cannot get air to breathe?

What to Do in the Lab

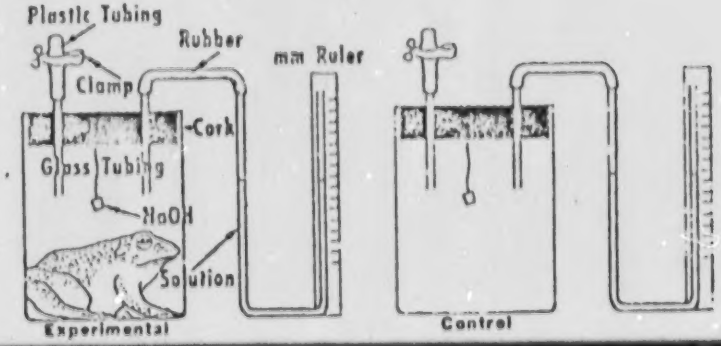
Place a small animal in a glass container with a wide mouth. Hang by a string a vial of sodium hydroxide pellets near the mouth of the container. (CAUTION: Do not let the dangerous sodium hydroxide pellets touch your skin.) Hold the string from the vial in place by inserting the stopper.

Connect the stopper to the tubing of the manometer (U-shaped glass tube which contains water and food coloring). Set up the second manometer as a control without the animal. (See illustration below.) The volumeter is another method used to measure respiration. Set up two volumeters as illustrated below, using one of the volumeters as a control. As soon as you make this connection, use a clock or watch to time every three minutes the changes in the liquid column of the manometer or the water drop in the volumeter. Use a ruler to measure the change of the liquid column of the manometer or the water drop of the volumeter.

VOLUMETER



MANOMETER



After 12 minutes open the stopper to let in fresh air. If the animal collapses at any time during the experiment, open the stopper immediately. If you fail to open the stopper, the animal will die from lack of fresh air.

Where to Go From Here

- Did the rate at which the column of colored water moved remain the same throughout the experiment?
- If it changed, why did it?
- What would happen if the animal were heated?
- What would happen if the animal were cooled?
- Would there be a difference between warm-blooded animals and cold-blooded animals?

If no sodium hydroxide pellets were used, the volume of the gases would remain the same.

- Would the kinds of gases change?
- How can you measure the percentage of oxygen in air?

Other Things to Do

Sodium hydroxide or lye quickly converts fats and oils into soap. A small dead animal such as a frog may be reduced to a skeleton by leaving the body in warm lye solution.

A burning candle will soon be extinguished inside a glass container as soon as most of the oxygen is consumed. If a large glass jar is placed over a burning candle floating on a wooden base in a pan of water (or simply a tall candle fixed to the base of a pan of water), the quantity of oxygen in air can be approximated by noting the rise of the water level in the glass jar.

- Are there some organisms that do not require oxygen?

PHOTOSYNTHESIS I

Exercise "B"

Objectives

At the end of this activity the student should be able to

- Determine the necessary raw materials and energy required for the manufacture of sugar and starch in plants.
- Determine that light energy is necessary for the manufacture of sugar in plants

Materials

2 Elodea plants or sprigs
Dropper bottle of bromthymol blue
Soda straw
4 test tubes
Solid rubber stopper or cork stopper for each tube
10 cm x 20 cm piece of aluminum foil
Several 75- to 100-watt light sources
Roll of narrow freezer tape
Test tube rack or wide mouth jar to keep test tubes upright

How to Get Started

Before you begin any lab work, try to tackle these problems.

- How does a plant differ from an animal?
- Why is a plant green?
- What must a plant do to grow?
- How would you describe the environment of a plant?
- List some ways that plants are alike and an equal number of ways

Secure four test tubes and four matching stoppers, one to fit each test tube. Also secure a test tube rack or support to keep test tubes upright.

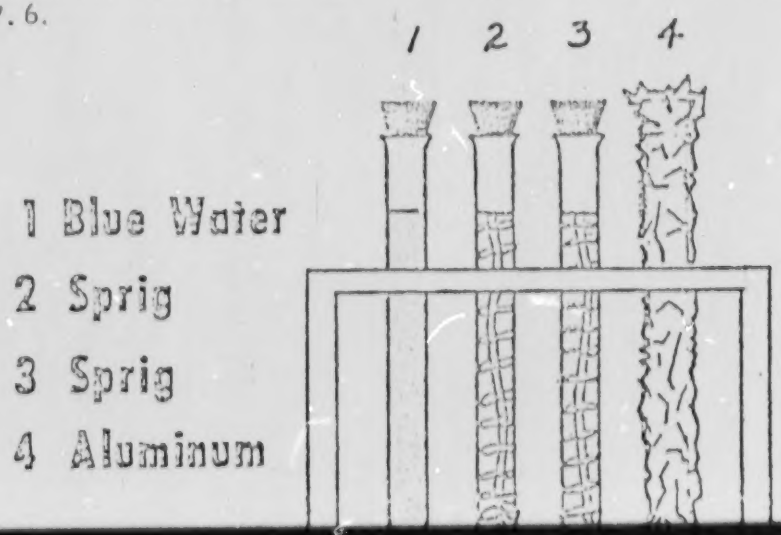
Examine each test tube carefully to be sure it is perfectly clean. If there is evidence of any foreign matter present, wash them with a test tube brush, a cleaner, and then rinse at least three times.

Label the outside of the tubes by taping a small square portion of masking tape on a clean dry side of each test tube. Write sufficient information to identify each tube.

Prepare bromthymol blue indicator following these steps:

- Prepare a 1.0 M solution of sodium hydroxide: To 20 g of NaOH pellets, add enough distilled water to make 500 ml of solution.
- Prepare a .01 M solution of sodium hydroxide: Dillute 5.0 ml of the 1.0 M solution of NaOH with enough distilled water to make 500 ml of solution.
- Grind 0.1 g of bromthymol blue powder with 16.0 ml of the .01 M sodium hydroxide solution. Add 234.0 ml of distilled water.

Bromthymol blue indicator changes from yellow to blue in a pH range of 6.0 to 7.6.



Place in a beaker 100 ml of tap water that has been stored overnight. Add to the water enough bromthymol blue indicator to change the color of the water to a very light blue. Fill the first test tube with blue water to within 2.5 cm of the top rim. Carefully blow through a soda straw that has been placed halfway down into the beaker of water making it bubble until there is a color change. Approximately one to two minutes of blowing should be sufficient. Pour the remaining water from the beaker into the other three test tubes filling each within 2.5 cm of the rim. Now place a sprig of elodea 6 cm long in test tubes 3 and 4 only. Finally, close the top of all test tubes with a stopper.

Wrap test tube number 4 with a piece of aluminum foil and place all the test tubes in a rack or support and allow them to stand near a bright light for 24 hours.

After you have completed the preparations, fill in the data table below, showing the basic information for each test tube you prepared.

No.	Contents of Tube	24-hr. Observations
1		
2		
3		
4		

Where to Go from Here

- What plant processes are causing the color or pH changes?
- Why did breathing in the colored water solution change the color?
- What does the color change mean?
- What is the relationship of the Elodea in the test tube wrapped in foil to plants growing in the dark?
- What inference could be made about what each plant is doing to change the color of liquid?

Other Things to Do

Find out if a green plant is only green. Secure a couple of fresh leaves from any deciduous tree, such as a pecan, maple, sweet gum, sycamore. Bring them to lab, tear them into small pieces, and fit them into a clean, fireproof test tube or small beakers.

Fill an empty tin can with hot water and carefully bring it to your work area. (CAUTION: Be sure there is no open flame in your area, as you will next be working with acetone, a very volatile chemical that ignites easily.)

Fill the test tube, containing the leaves, within 4 cm of the top with acetone, a colorless chemical solvent. Set the test tube containing the leaves and acetone in the container of hot water long enough for the leaves to lose their green color and become very pale.

Meanwhile, secure a clean, empty 250 ml beaker and 2 pieces of round filter paper. Make a narrow slit in the center of one filter. Fold the second piece so that it can be inserted through the slit you have prepared and hang it downward.

Pour the green colored liquid from the test tube into the clean beaker. Allow the pieces of the leaves to remain behind in the tube. Place the round filter paper with the center slit over the beaker mouth, with the folded paper hanging down like a wick to absorb the green liquid. As the liquid spreads upward to the top filter paper, it will form a circular pattern on the upper piece of filter paper that serves as a cover over the beaker.

- What color was each pigment that was extracted?
- How many different pigments can you distinguish that were extracted from the leaf?
- What is the role of pigments in a leaf?
- Why do different pigments move at different rates up the filter paper?

PHOTOSYNTHESIS II

Exercise "B"

Objective

At the end of this activity the student should be able to determine that light energy is used by green plants.

Materials

Elodea sprig
1 beaker
Large test tube or graduated cylinder
lamp
Sodium bicarbonate
Ruler
Watch with second hand
Thermometer
pH paper (pH range 6-8)
Red, blue, and green cellophane paper

How to Get Started

Fill beaker nearly full of water, and place lamp about 15 cm away from the beaker. Fill test tube or graduated cylinder nearly full of 0.05% sodium bicarbonate solution. A 0.05% solution of sodium bicarbonate would include .5 g of sodium bicarbonate in one liter of distilled water or tap water that has stood over night. Place sprig of Elodea in the test tube with the cut end uppermost.

What to Do in the Lab

Place the test tube in the beaker of water and turn on the light. Measure the pH of the bicarbonate solution. After a few minutes the elodea sprig should begin to photosynthesize. This can be detected by the bubbles of oxygen that emerge from the cut stem of the Elodea If bubbles do not soon appear, cut off a bit of the stem so that a freshly cut end is exposed.

When bubbles are produced with regularity, count how many appear in a 60-second interval.

The process of photosynthesis is the use of light energy to convert carbon dioxide and water into sugar and oxygen. The general chemical equation is:

$$\text{light} + CO_2 + 2H_2O \xrightarrow{\text{chlorophyll}} CH_2O + O_2 \uparrow + H_2O$$

In order to be used, the light energy must first be absorbed by the chlorophyll in the leaf of the plant.

Move the lamp 7.5 cm away from the beaker and once again record the pH of the solution and the number of bubbles per minute. Take several readings to be sure a constant rate is achieved.

Move the lamp again to a distance of 30 cm from the beaker and then take another set of readings. Continue to move the lamp until further distances produce no reduction in rate. Plot number of bubbles per minute against distance from light to beaker using the graph on the next page.

Repeat the experiment with the lamp near the beaker but cover the lamp or the beaker with blue cellophane. Record the one-minute bubble counts. Repeat using red cellophane and green cellophane.

Where to Go from Here

- How much faster or slower were the bubbles produced when the lamp was at 7.5 cm than at 15 cm?
- What inferences can you draw about the amount of energy available to the plant when the lamp is placed at a distance of, say, 15 cm, compared to 30 cm?
- Did the pH change as photosynthesis proceeded?
- What could cause the pH of the solution to change? (Hint: Measure the pH of distilled water and compare it to the 0.05% sodium bicarbonate solution.)
- Why was the plant placed in the bicarbonate solution?
- Which wave lengths of light are the most effective for photosynthesis?
- Does this give you a clue about why the chlorophyll in leaves is green?

Other Things to Do

Attach a manometer to the top of the test tube containing the photosynthesizing sprig of Elodea and measure the volume of O_2 evolved.

Try varying the amount of bicarbonate in the solution. Begin with distilled water which has been boiled to drive out the dissolved CO_2. This should, of course, be allowed to cool to room temperature before putting in the Elodea.

FOOD PYRAMID IN A HAY INFUSION JAR

Exercise "C"

Objectives

At the end of this activity the students should be able to

- Demonstrate how living organisms are dependent on each other by a food pyramid in a hay infusion jar
- Recognize algae and fungi, small ciliates, paramecium, and rotifers

Materials

Microscope
Eyedropper
Gallon jar with wide mouth
Pot
Baby food jar
Glass piece for covering gallon jar
Small paper sack
1 light bulb, 100 watts
1 hot plate or Bunsen burner with ring stand
1/2 package of bean seeds
Tap water

What to Do in the Lab

Obtain some dry grass, and cut it into small pieces. Place dried grass into a pot of tap water. Bring the contents of the pot to a boil over a hot plate. Pour the boiled water and the grass into a gallon jar. Let the water cool to room temperature then pour some pond or ditch water into the infusion. This water must come from a "healthy" pond. Place a piece of glass over the mouth of the jar and set it under the light. You can fix a 100-watt lamp from a structure two feet above the gallon jar hay infusion.

This infusion will last for six months if seeded from time to time with rotten bean juice. To seed the infusion, pour a small amount of bean juice into it. Prepare the bean juice by placing half the package of bean seeds in a baby food jar filled with water and then place the lid on tightly and soak for several days.

Each laboratory period take a sample of water from the top of the hay infusion with an eye dropper, place it on a slide, and cover the slide with a cover strip. Put the slide on the microscope stage and look through the ocular. Make drawings of what you see and estimate the numbers everyday for two weeks. Perhaps the teacher will show a film or filmstrip on microscopic life as you do your work with the microscope. At the end of each week write a summary of what you saw.

Where to Go from Here

Set up your own system of classification to determine what plants and animals appear and when.

- How did the organisms get into the jar in the first place?
- Name the animals that you observed.
- What happened to the large organism?
- Which groups are larger in numbers, plants or animals?
- What is the purpose of hay in the hay infusion?

. Why is the hay boiled?

. Why is it necessary to place the hay infusion under a light?

. What type of organisms will appear in the jar first?

. Which will appear first, plant or animal life?

. Why are rotten beans used to seed the hay infusion jar periodically?

. What kinds of plants and animals are found in ponds?

. What do they eat?

Other Things to Do

Place all six gallon jars under one light source. Place four of the jars in different areas in the room; the two remaining jars will serve as a control. Every day over a two-week period record the hay infusion temperature. Take samples from the surface of the culture and estimate the population. Determine the amount of heat energy necessary for a good hay infusion.

DIGESTION AND ENZYME ACTION

Exercise "D"

Objectives

At the end of this activity the student should be able to

- Recognize the effect of an enzyme in saliva or starch
- Use indicators to show changes caused by enzymes
- Test for starch and sugar

Materials

Bottle of corn syrup (sulfur free)
Three salt-free crackers
Seven heat-resistant test tubes
Dropper bottle of iodine solution
Dropper bottle of Benedict's solution
China marking pencil
Heat source (burner, canned heat, or candle)
Test tube rack or low wide-mouth jar for support
Test tube holder
Box of clean rubber bands

How to Get Started

When you eat a meal, one of the first things you do is chew and moisten your food. Tackle the following problems to see how you will react:

- Why must we chew our food?
- What must happen to the food before your body can receive any benefit?
- How can you tell if a food has sugar in it?

- What is starch?
- How can one tell if starches are present in foods?

Cautions

- All students must be aware of how to handle hot test tubes to prevent mishaps.
- Be sure all test tubes are thoroughly washed before they are used.

Preparation

In advance of this activity you will need to prepare or purchase from a drug store two solutions for use in lab. Tincture of iodine may be used in starch tests.

Preparation of Benedict's solution (This recipe will make 1 liter of solution):

- Pour 700 ml of distilled water into a clean half-gallon container. Dissolve in it 173 g of potassium or sodium citrate and 200 g of sodium carbonate or 100 g of anhydrous sodium carbonate. To aid in dissolving the solids, warm the water before dissolving. Filter the solution after dissolving.
- In a clean beaker or jar, pour 100 ml of distilled water and to it add 17.5 g of copper sulfate. Stir to dissolve the solids.
- Pour the two solutions together and stir. Then add enough distilled water to make 1 liter of solution.
- Fill dropper bottles for teams. Prepare another dropper bottle with iodine solution for each individual or team. (Note: If you do not have a generous supply of dropper bottles, have teams share.)

What to Do in the Lab

When the lab session begins, you will want to work with a partner. Your teacher will provide you with the items you will need in this activity. After you have gathered what you will need, crush a cracker into a fine powder inside a folded sheet of notebook paper. Place the powder in a test tube and label the tube No. 1 with a marking pencil.

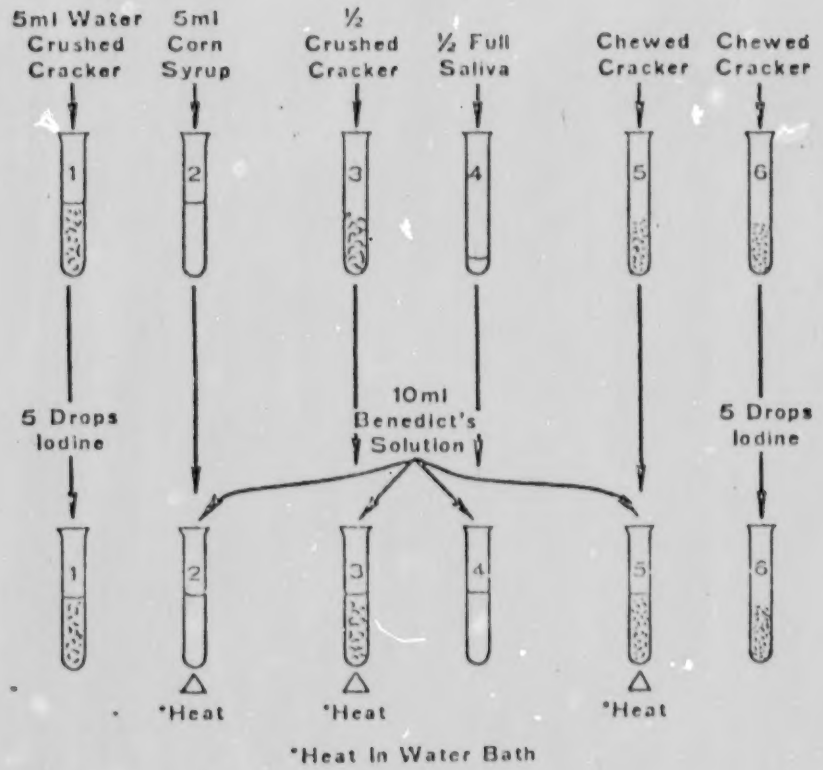
To test tube No. 1 add 5 ml of water and 5 drops of iodine solution. Shake the test tube gently. Record your findings on your data sheet.

To the next test tube, No. 2, add 5 ml of corn syrup and 10 ml of Benedict's solution. Then heat the contents for several minutes in a water bath. Record what you see.

Next, place 1/2 of a crushed, dry cracker into a third test tube and label it No. 3. Add 10 ml of Benedict's solution and heat for a few minutes. Record your observations and conclusions on your data sheet.

Label the next tube No. 4. One of the lab partners should chew on a rubber band to stimulate the flow of saliva in his mouth. When enough saliva is present, use a clean straw to transfer the saliva from the mouth to test tube No. 4. Place 10 ml of Benedict's in No. 4 and watch for a change. Record what you see.

Next another team member should chew a piece of a cracker thoroughly without swallowing until it is a liquid in the mouth. Deposit half the chewed material, by the use of a straw, in a test tube labeled No. 5, and the other half in a test tube marked No. 6. Add 10 ml of Benedict's solution to No. 5 and shake gently. Then heat for several minutes in a water bath. To No. 6 add iodine and observe. Record what you see happen to No. 5 and No. 6.



Data Sheet

Prepare a data table similar to the one below:

Test Tube Number	Contents	Observations	Conclusion
1			
2			
3			
4			

Where to Go from Here

- What is the purpose of adding Benedict's solution or iodine solution?
- Why did you heat test tube No. 2?
- What is the difference between test tubes No. 2 and No. 5?
- Is saliva important? If so, how?
- What was the purpose of the test on No. 1 and No. 2?

Other Things to Do

Prepare two other test tubes, each with saliva and crushed cracker. Heat one test tube and leave the other at room temperature. Then add a couple of drops of vinegar to each tube. Record the results you observe on the reverse side of this instruction sheet. Try to account for what you see.

ACTION OF ENZYME ON MILK

Exercise "E"

Objectives

At the end of this activity, the student should be able to

- Describe the enzyme action in the coagulation of milk protein
- Describe the effect of pH and heat on activity of enzymes
- Relate the enzyme activity to the breakdown of food during the process of digestion

Materials

1 cup milk
1 1/2 tablespoons sugar
1/2 teaspoon vanilla
1/2 rennin tablet
1/2 tablespoon cold water
2 small paper cups
Other flavoring as desired

How to Get Started

Mammals, particularly young ones who feed on large quantities of milk have an enzyme in their gastric juice which promotes the coagulation of milk protein. This enzyme, rennin, aids in digestion by making the protein more susceptible to the breakdown by other enzymes. It is available commercially for use in making cheese and puddings. Tablets can be found in most grocery stores. Junket Rennin tablets work well.

What to Do in the Lab

Combine milk with sugar and flavoring and heat to lukewarm (43° C). Crush 1/2 tablet of rennin and disperse in water. Add rennin solution to warm milk and stir for a few minutes only. Pour at once into paper cups. Let stand undisturbed for 10 minutes. Chill.

Controls for this exercise are as follows:

1. Omit the rennin from the mixture.
2. Boil the rennin solution before you add it to the warm milk.

Where to Go from Here

- Did the boiled rennin react the same as the unboiled rennin solution?
- What happened when the rennin was omitted from the mixture?
- The pH of the stomach is very low. What would the action of this enzyme be in an alkaline solution?
- Rennin is one of several digestive enzymes in your stomach. Do any of the others act on proteins?

Other Things to Do

Separate the egg white and add an equal amount of water. Heat gently to lukewarm (43° C). Do not overheat. Crush 1/2 tablet of rennin and disperse in water. Add the rennin solution to the egg white and stir for several seconds. Cool and let stand for 10 minutes. Compare the activity of milk protein to that of the egg protein.

NUTRITION

Exercise "F"

Objectives

At the end of this activity the student should be able to

- Recognize the importance of a proper diet
- Determine mass in grams
- Observe differences in animals' appearance

Materials

2 laboratory-bred rats or hampsters of same age, litter, and sex. (Rats 23 to 28 days old respond best. They should be as close to the same weight as possible.)
2 cages
1 scale
Soap and small brush to clean cages
Container to mix and store food
A coffee can with holes punched in lid for weighing (Oatmeal cartons also are suitable.)
Tags for each cage
Food for demonstration
4 containers for food and water

How to Get Started

Two rats are a minimum for the activity. Four would ensure against failure if something happened to one rat. Rats must be marked if you keep more than one in a cage. They can be marked by using a dye or permanent ink. Make sure the dye is not toxic as the rat will try to wash it off. The mark must be renewed as it begins to fade.

Citrus fruit, tomato, or cabbage need not be supplied for the rats' diet because they do not have the same vitamin C requirements as humans.

They might be included in a well-balanced diet to remind students of their own need for them.

Rat-feeding demonstrations usually take from 7 to 8 weeks to show results. This amount of time may vary, depending on the diets of the rats.

Responsibilities in maintaining animals include

- Cleaning cages
- Changing paper on bottom of cages daily
- Washing food containers each day
- Washing cages with soap and water each week
- Feeding animals on a regular schedule--twice a day (Give greater variety in the afternoon feeding because rats prefer to eat at night. Double the quantities fed over a weekend.)
- Recording data (Some students will have the responsibility for plotting the rats' growth--the weeks against mass in grams.)
- Keeping a record of food consumed for two full days before the experiment begins

What difference will food make in the growth and appearance of these rats? List some changes you might expect to see if one were on a poor diet? How are rats similar to human beings?

What to Do in the Lab

Place one rat in each cage. Make sure the food and water containers are clean. One, for instance, could be fed the food offered in school cafeterias, including a grain food, fruits and vegetables, a dairy food, and a protein food. The other rat could be fed a hamburger, potato chips, and soft drink. Give each rat fresh food and water every day. The teacher may provide contrasting diets to be used or may ask you to decide on diets for two rats.

Each rat should be fed two ounces or 60 grams daily. Feed the rats two times daily. Decide upon the most convenient times for feedings.

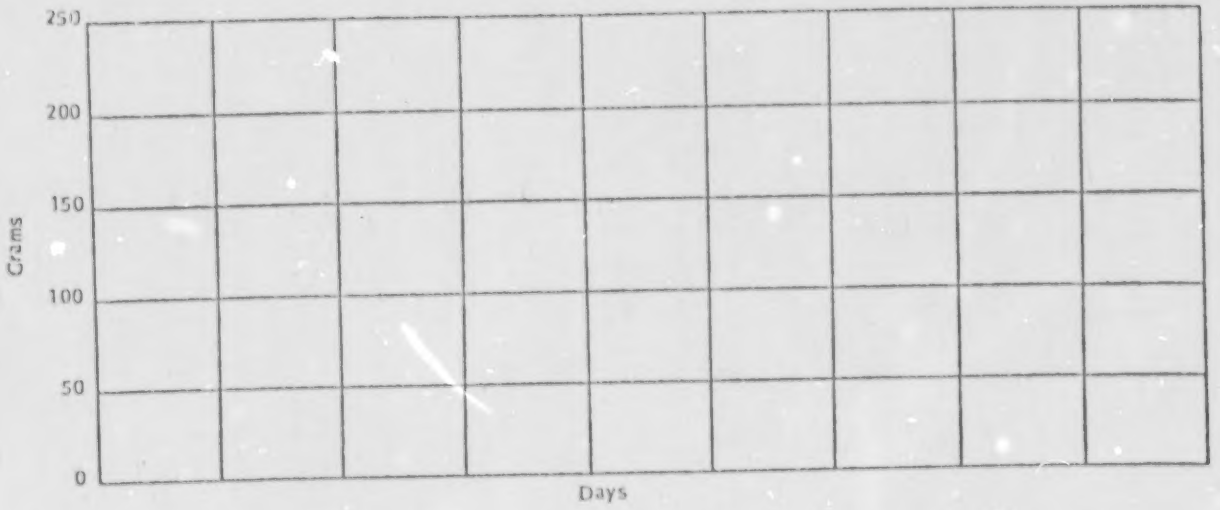
The papers in the cages must be replaced daily, and the cages must be scrubbed with soap and water each week.

Weigh the rats each day. The greatest contrast between the two rats will be in weight. Other differences you might look for follow:

Well-nourished Rat*	Poorly nourished Rat
Clean, smooth, glossy fur	Shaggy, dull, and possibly thin fur
Smooth tail, free from roughness	Rough, dry, scaly ears, feet, tail
Brig pink eyes; pinkish nose, ears, feet, tail	Eyes not clear; pinched look in face
Clean and tidy habits	Whiskers not long and sharp and possibly dirty
Quick, alert movements; good muscle control	Restless, irritable, and cross
Easily handled, good natured	Breathing difficulty, susceptible to "sniffles"
Firm nails	Possibly soft nails

On each cage record the name of the rat, starting weight, and date. Keep a record every day of weight, appearance of fur, tail, eyes, and nails for each rat.

Make a graph as follows:



When you notice that one rat shows many symptoms of malnutrition, start feeding it a regular diet.

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*National Dairy Council, "Animal Feeding Demonstrations" (Chicago: The Council), 1958, p. 13.

Where to Go from Here

Which rat seemed healthier? In what ways? What are some other factors that might have caused a difference in the rats' appearance? Did you notice any difference between the two rats besides those mentioned?

EXAMPLE OF A RAT-FEEDING DEMONSTRATION USING DRY FOODS

Diet 1

One or two rats are fed a diet which includes milk, meat, and cereal in the form of flour, butter, vegetables, sugar, salt and cod liver oil as follows:

Foods	Weight in grams	Approximates a human daily diet of:
Dried milk	400	4 cups of milk
**Dried meat	80	1 serving of meat
Whole wheat flour	200	cereal
White flour	200	4 slices of bread
**Dried spinach or alfalfa leaf	15	2 servings of vegetables, potatoes, one serving of fruit
Raw carrot	any amount	
Sugar	40	Small amount of jam, or sugar in dessert
Salt	15	Small amount used for seasoning
Butter	50	2 tablespoons butter
Codliver oil	40	3 teaspoons codliver oil

**Available at a local feed store.

Diet 2

The second rat or pair of rats is fed similarly but has only a little milk, slightly less meat, a large amount of vegetable fat instead of a modest amount of butter, a large amount of sugar, no codliver oil.

Foods	Weight in grams	Approximates a human daily diet of:
Dried milk	50	1/2 cup milk in cooking
**Dried meat	56	1 small serving meat
Whole wheat flour	200	cereal
White flour	200	4 slices of bread
**Dried spinach or alfalfa leaf	15	2 servings of vegetables, potatoes one serving of fruit
Raw carrot	any amount	
Sugar	264	Large amount of sugar in jam, candy, dessert
Salt	15	Small amount used as seasoning
Vegetable fat	200	Fat in cooking and rich desserts

**Available at a local feed store.

Mixing of Diets and Feeding

Weigh and thoroughly mix the foods listed. Combine the dry foods; add the melted butter or a liquid vegetable oil, according to the diet. These quantities should last about four weeks or half of a recommended 8-week demonstration. Store in a covered can, in a cool, dark place. Give the rats fresh food and water each day. Put the food in clean jars with that left over from previous feeding on top (making sure that it is not spoiled). Keep a clean, raw carrot in the cage.

Discussion

Of the two diets, one illustrates a diet recommended for good nutrition and the other is quite inadequate. It is like that of a child who refuses or is not given milk and codliver oil or vitamin D milk, except for a little milk in cooked foods, and who eats large amounts of highly sweetened and rich foods.

A study of Diet 1 shows it to contain generous amounts of protein, calcium, iron, and vitamins. Students should note the omission of citrus fruits, and it should be explained that the rat differs from humans in that he does not need vitamin C.

Diet 2, however, is outstandingly low in calcium and contains much less protein chiefly because of the decrease in milk. Diet 2 is much lower also in vitamin A since there is no butter, no codliver oil, and only a little milk.

The rats fed on these contrasting diets will respond nutritionally much as would children. Watching the rats grow and develop, pupils will observe differences in weight, appearance, and behavior. It is suggested that the study be continued for 8 weeks, reversing the diets after 4 weeks.

Applications to Students' Eating Habits

A display of food models showing sample menus for Diet 1 as compared with Diet 2 in terms of children's eating patterns will be helpful. For example:

DIET 1

Breakfast
- Orange juice
- Oatmeal with milk
- Buttered toast and cocoa (milk)

Lunch
- Macaroni and cheese
- Tossed vegetable salad
- Muffin and butter
- Milk
- Fruit gelatin

Snack
- Milk, raisin cookie

Dinner
- Meat patty
- Green beans
- Milk and ice cream

DIET 2

Breakfast
- Orange juice
- Sweet rolls, 2

Lunch
- Bread and jelly
- Salad
- Carrot sticks
- Frosted cupcakes

Snack
- Popcorn, soft drink

Dinner
- Meat patty
- Mashed potato
- Green beans
- Bread and jam
- Apple pie (two pieces)

Students may record their daily meals for a short period before the demonstration as a means of finding the needs for stress. Repeating this after the demonstration helps to show the effectiveness of the study.

REPRODUCTION AND GROWTH

Exercise "G"

Objectives

At the end of this activity the student should be able to

- Describe how animals reproduce and grow
- Determine various levels of cellular organization
- Measure size changes with a ruler, and graph the changes observed

Materials

Fertilized eggs from hatchery
Baby food jars with tops (one per team)
Weak alcohol or formaldehyde solution for each jar
Electric incubator

If no incubator is available, then you will need the following items:

Small aluminum pan for water
Centigrade thermometer
Light cord
Light bulbs (40, 60, 75 watt)
Freezer tape
6 cm x 8 cm glass or plastic (Clear plastic wrap could be substituted.)
Two cardboard boxes with tops (one 20 cm x 12 cm x 12 cm and one large enough to hold that one)
Newspaper for insulation

Cautions

- Be sure that the light cord you use has safe wiring and doesn't appear to be frayed.
- The eggs you purchase must be fertile. Ordinary supermarket eggs will not do.

How to Get Started

In this laboratory activity you will want to watch and measure the growth and development that takes place inside a fertilized egg. Discuss the following questions with your classmates and teacher:

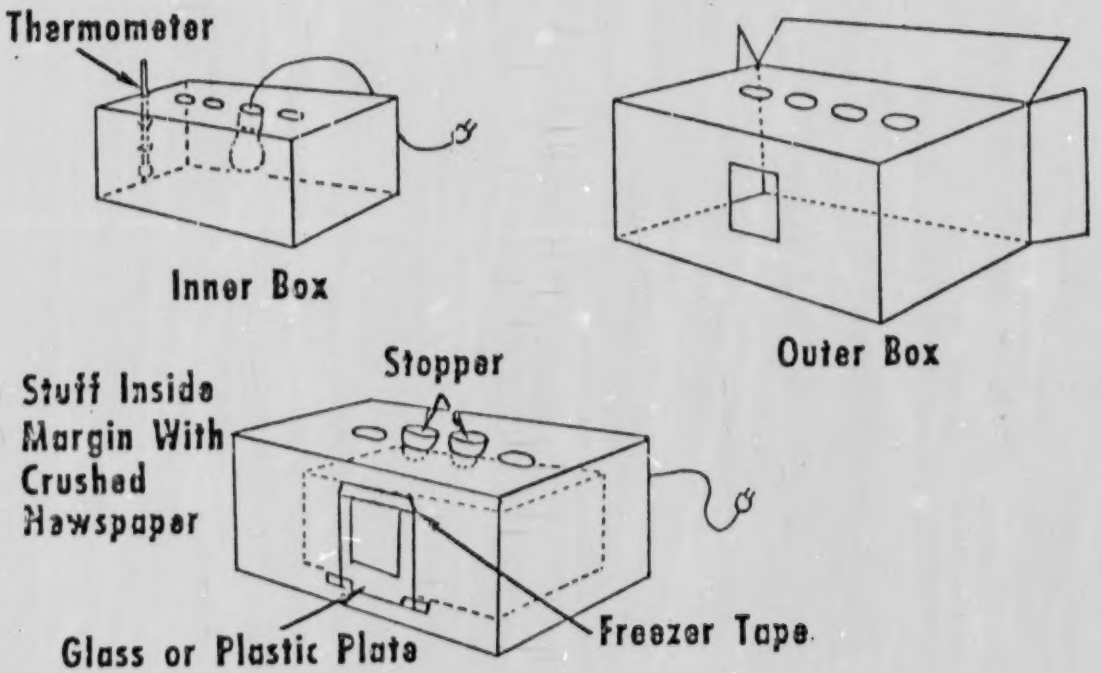
- How do you know when a thing is alive?
- Why must every living thing have a method of reproducing itself?
- How can one find out about the development of organisms?
- What is the purpose of using an incubator?

What to Do in the Lab

View pictures of the various stages of the development of a chick. Students may consult their own texts or an encyclopedia.

If it is necessary to construct a simple incubator, see the following illustration. Obtain two cardboard boxes, one about 20 cm x 12 cm x 12 cm

INCUBATOR CONSTRUCTION DIAGRAM



and another large enough to allow the first box to fit inside with ample room to spare on all sides. Stuff crushed newspaper in the ample outer margin to completely insulate the inner box. Insert a light into the top of the small box so that it dangles downward inside. Cut a small square hole through both box layers for viewing purposes. The bulb of a thermometer should be at the same level as the eggs when they are in the incubator. Use an aluminum pan with water to prevent the eggs from drying out.

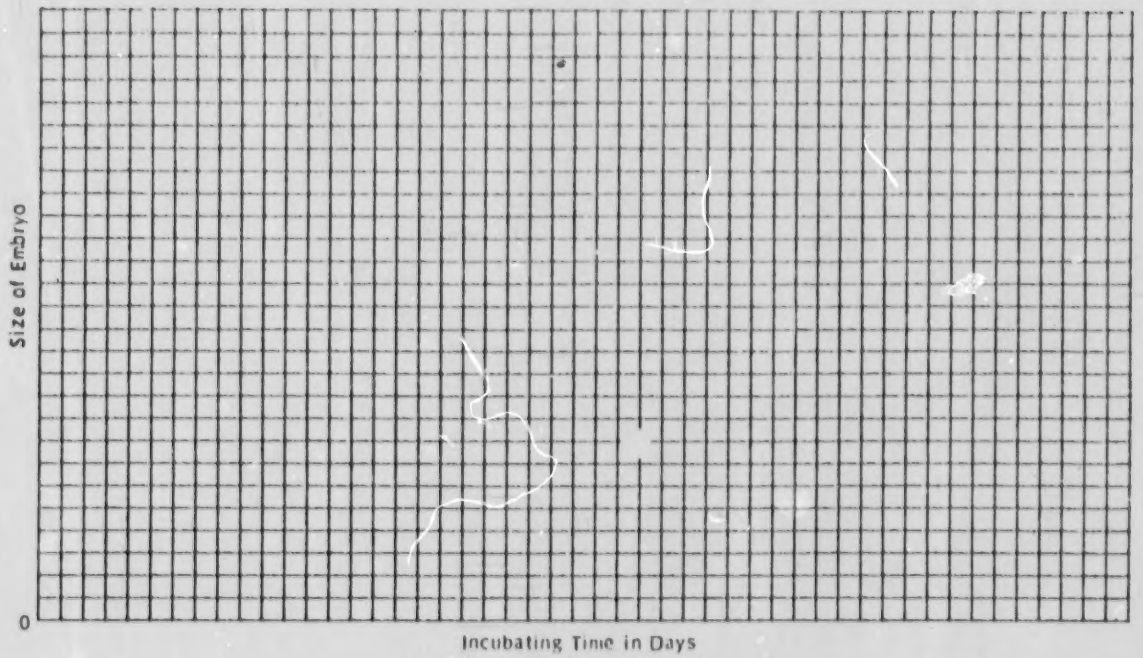
Turn on the light. After one hour, note the temperature in the incubator. Try bulbs of different sizes until the temperature in the incubator remains constant at 39°C. Make holes through the tops of both boxes and either plug or unplug them until the temperature comes to rest at 39°C. Do not put eggs in the incubator until the temperature remains constant at 39°C for a couple of days.

Obtain some fertilized eggs from a farmer or hatchery. (Do not use eggs from a local grocery, as they are usually not fertile.) The class may be divided into teams of two. Each team is to have two eggs. Candle each egg to determine if it is really fertile. This may be done by placing each egg over a hole cut into the bottom of an inverted empty juice can that has been placed over a light bulb. Fertile eggs will show a dark spot near the yolk.

After candling, place all eggs in cartons and close. The teacher will designate certain cartons for specific classes, and two eggs in one of those cartons for each team. Place all cartons in a preheated adjusted incubator. Support cartons on edge so that the long axis of the eggs will lie in a horizontal position. Flip the egg positions daily. It is wise to begin incubating on a Monday morning as this will allow the observations on Tuesday through Friday.

The eggs should then be labeled with time and date. Each group should candle its incubating eggs every second day to observe and measure the growth. When eggs are being candled, you can measure the approximate size of the embryo with a ruler and record on a chart. Then plot the size against incubating time. Be sure that eggs are handled with clean hands and replaced immediately so as not to interrupt the incubating process. See the following chart.

GRAPH OF INCUBATING TIME VERSUS CHICK SIZE



After the observation, one group should determine the mass of the entire egg before it is opened. After weighing the egg, break open one egg by carefully opening the part of the shell that was facing upward. (Your teacher will designate when your group will open an egg.) This can be done with a pair of scissors by punching a little hole in the shell, and then cutting around the top, creating a window of about 2.5 cm in diameter for observations. Refer to illustration. As each egg is opened, look on your data sheet and record which item you saw appear, and when it appeared. **Also refer to pictures or films.**

DIAGRAM FOR OPENING INCUBATED EGG

A. Punch Small Hole Here

B. Cut Around In A Circle

C. Embryo And Yolk

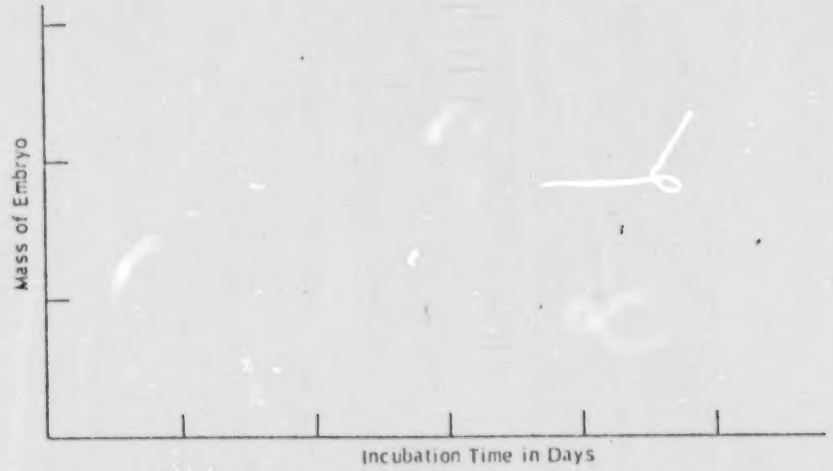
GROWTH AND DEVELOPMENT DATA SHEET

ITEM	DATE FIRST OBSERVED	OTHER OBSERVATIONS
Blood Vessels		
Heart		
Head		
Feathers		
Muscles		
Feet		
Wings		
Legs		
Spinal Cord		
Yolk Sac Blood		
Heart Beating		
Beak		
Eye		

After the class has seen the chick embryo, the embryo should be lifted from the yolk with forceps and snipped free with scissors. Transfer the embryo to a jar containing rubbing alcohol that has been diluted half with water. (If formaldehyde is available, use a dilute solution.) The embryo should then be weighed by the team members and the following measured:

1. Mass of entire egg
2. Mass of jar and alcohol
3. Mass of jar, alcohol, and embryo

Announce the results of Step 3 to the other members of your class so they may plot the incubating time and mass on a graph. The mass should be marked along the left edge of the graph and the time along the bottom of the graph.



NOTE: To determine percentage, divide the mass of the embryo by the mass of the entire egg. Multiply the answer by 100 for the percent. Keep the jar lid tightly sealed so that none of the liquid evaporates. You should monitor two eggs and the growth inside them for 21 days, until normal chicken eggs hatch.

If conditions are ideal, eggs will hatch on the twenty-first day. Move chicks to a 27° C area after hatching.

Where to Go from Here

- How does the growing embryo get rid of its waste products?
- When is an organism dead?
- What is an organism in relation to tissue?
- Observe the yolk as it disappears. Determine what percentage of the entire egg the embryo is as it grows. Keep a record of the increasing embryo percentage and the decreasing yolk percentage.

Other Things to Do

Collect clumps of frog or snail eggs. (Frog eggs may be collected in the spring from ponds or streams.) Put about 20 eggs in each dish with pond water. Observe and keep a data log on frog or snail development on Mondays, Wednesdays, and Fridays. Put them in fresh pond water on Mondays and Fridays.

Remove any eggs that have the white side up and seem to be dead. Observe and record the developmental growth of the animals. Compile a list of drawings of the developmental stages of the frog or snail that was observed by the class.

BEHAVIOR AND ENVIRONMENT

Exercise "H"

Objectives

At the end of this activity the student should be able to

- Identify stimuli and measure the reactions to the various stimuli
- Observe and draw on graph paper the paths made by isopods or pill bugs in a humidity gradient chamber

Materials

Pill bug racetracks
Pieces of cardboard 24 cm x 76 cm long
2 baby food jars with perforated lids
Graph paper cut to size of racetrack
Cobalt test paper strips and 1 box of cotton balls
16 oz. desiccant (calcium carbonate or calcium sulphate)
Calcium chloride
Small bottle of nail polish, colored lacquer, or liquid eraser, some different colors
Watches or stopwatches, or 1 wall clock with second hand
Roll of masking tape or plastic tape
2 baby food jars with airtight lids
Desk lamps
1 roll of clear plastic wrap
2 sheets of graph paper

How to Get Started

- Will the isopod spend more time in the humid than the dry half of the chamber?
- Will the isopod be more active in the humid or dry half of the

- Where in this chamber will this animal rest more?
- Will the isopod make more turns in the dry half than the wet half?
- The isopod walks faster in the dry half than the wet half. Explain.

What to Do in the Lab

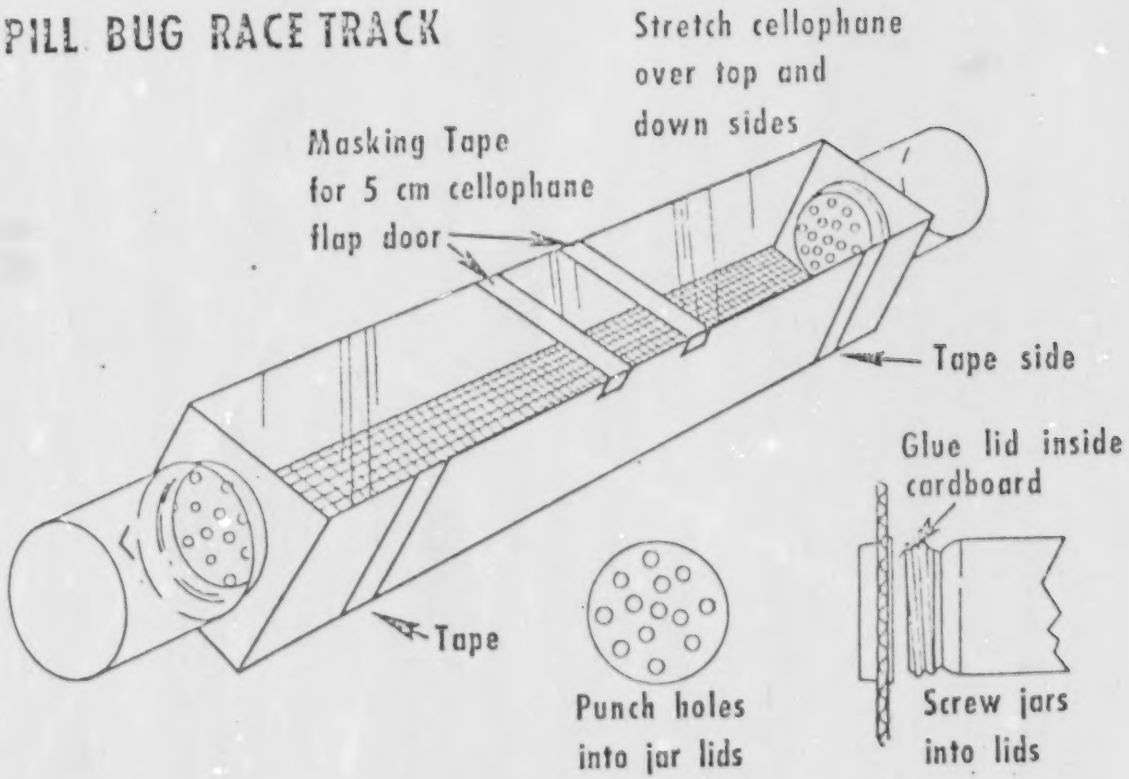
Each group of two students should assemble a gradient chamber as in the diagram on page 48. The humidity gradient chamber of the "pill bug racetrack" should be tightly sealed in order to maintain the humidity gradient. To establish a gradient of humidity the chamber should be left alone for 24 hours with the desiccant at one end and the moist cotton balls at the opposite end in the racetrack.

The desiccant must be oven dried before use. Cobalt chloride test strips could be placed inside the racetrack chamber near the ends to serve as indicators of moisture. The cobalt chloride test strips will be blue when dry and pink when wet or moist. Place the test strips in the middle and at both ends of the chamber.

The pill bug racetrack could be assembled during several class periods, then closed and used the following day. Use different color lacquers to mark the pill bugs. The animals should be placed through the opening in the top of the box. A 60-watt desk lamp should be placed over the top of the chamber to make sure the chamber is uniformly lighted. Use a control by allowing some students to place water-soaked cotton in both ends of the chamber. Allow others to place a desiccant in both ends of the chamber. Isopods may be found in moist places under leaves or rocks. To keep these alive, place them along with the leaves and soil into a coffee can. Put a small piece of uncooked potato on top of the material and cover the top with a plastic lid.

Keeping the humidity gradient constant, determine the animals' response over a peiod of time to this environment. Another idea would be to remove the desiccant from one end of the chamber and replace it with several cotton balls soaked in vinegar and at the opposite end have cotton soaked in water. Leave the chamber alone for 24 hours before the experiment. Draw the movements on a piece of graph paper. Other animals such as snails, earthworms, and mealworms could be used in this race-track with similar activities.

PILL BUG RACE TRACK



Dip a pencil into a jar of nail polish and carefully place a mark on one isopod's back. Mark another isopod with another color. Pick up the isopods carefully and place them through the opening at the top of the racetrack. Allow them three minutes to become used to the box. During this time cut out graph paper to the size of the base of the racetrack. Use a stopwatch or wrist watch and for 30 minutes draw the movements of your isopod in the chamber on your graph paper. Take care to draw the paths as accurately as possible. Mark one end of the graph paper moist and the other end dry. Both students should do this. Measure the time the animals stay in one-half of the chamber. Make a record of this time on the back of the graph paper.

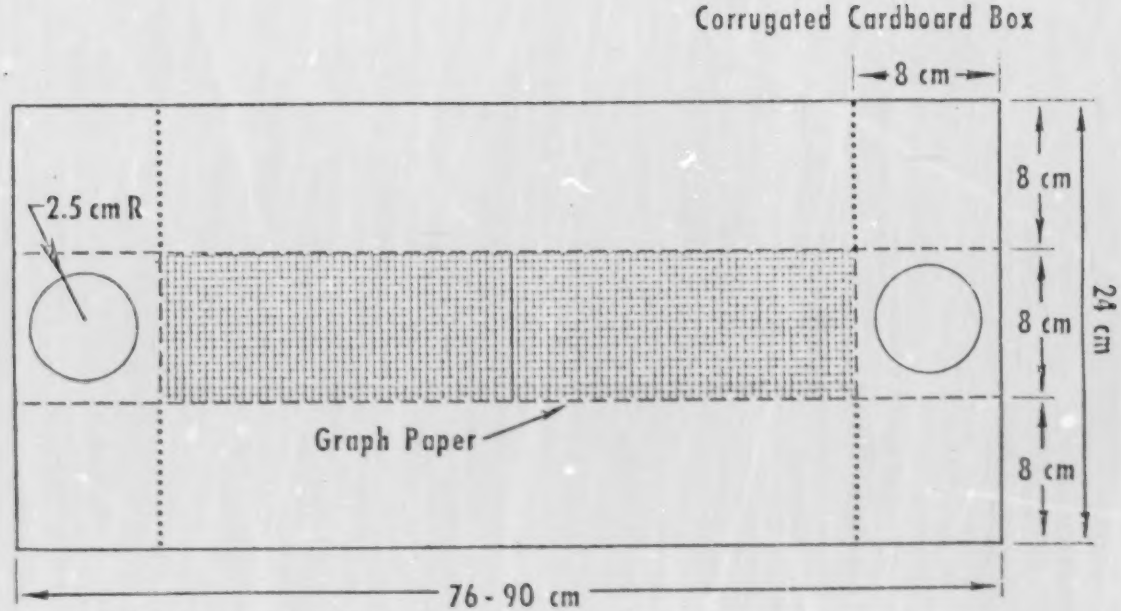
Where to Go from Here

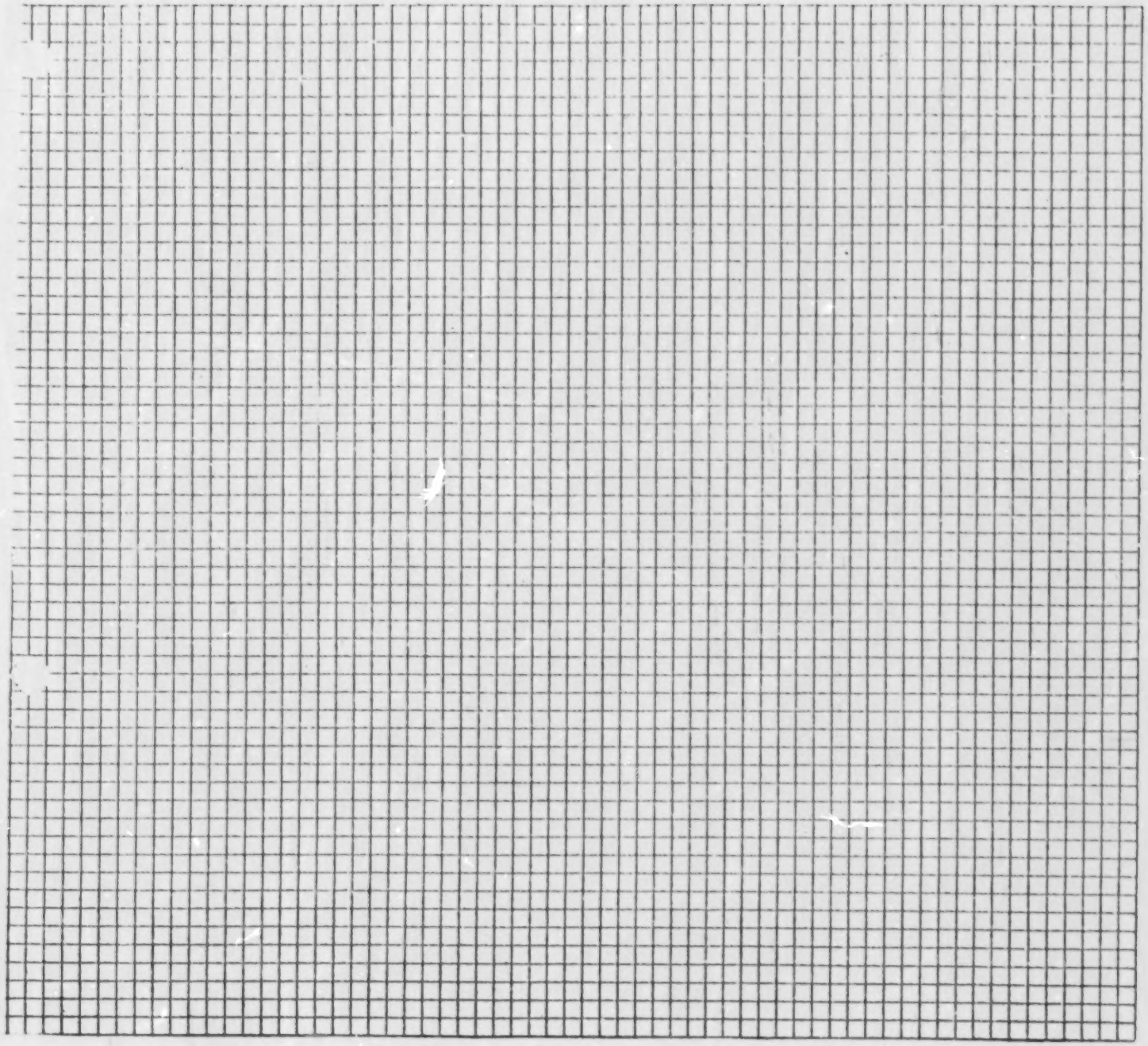
- Are isopods more prone to stay in the humid or dry end?
- Were there some that did not respond by moving to either end?
- What differences in the speed of walking in either end did you observe? From this activity, write a statement stating the type of habitat this animal prefers.

Other Things to Do

To continue this experiment, determine whether the pill bug responds more favorably with light or semidarkness if the humidity gradient is kept at a constant. Cover half of the racetrack with foil and leave the other half exposed to the light. Time how long the pill bugs stay at one end. Move the foil to the opposite end; measure how long the animals remain at one end of the chamber. Perhaps a piece of potato could be placed at one end of the chamber and no food at the opposite end.

PILL BUG RACE TRACK





THE EFFECT OF DETERGENTS ON THE GROWTH OF ALGAE IN PONDS AND STREAMS

Exercise "I"

Objectives

At the end of this activity the student should be able to

- Demonstrate the effect of commonly used washing detergent on the growth of algae (algae bloom) in fresh water ponds and streams
- Contrast the growth of algae in two samples of fresh water--one with detergent and one without detergent
- Infer the condition of algae growth in ponds and streams that are polluted with detergent and in those that are not polluted

Materials

2 gm of detergent commonly used for washing clothes or dishes in the home
2 wide-mouth glass jars such as pickle or mayonnaise containers
Culture of fresh water algae such as that growing in stock ponds, open ditches, bayous, fish aquaria
2 liters of distilled water
1 light source such as a table lamp or projector

How to Get Started

- What effect does the home dishwashing and automatic washer detergent have on the growth of algae in our fresh water ponds, lakes, and streams?
- Why is the amount of algae growth in ponds and streams important to us?
- How can dumping washer suds into our sewers affect fishing at a

favorite lake or river? If this is a problem what can we do about it?

What to Do in the Lab

Prepare a .1% solution of any common dishwashing detergent by dissolving 2 grams of the detergent in approximately 2 liters of water.

Fill one or several one-gallon jars with the detergent mixture and add one tablespoonful of green algae culture per bottle.

Fill several other one-gallon jars with distilled water and add exactly one tablespoon of algae to each bottle.

Cover the jars with a piece of cardboard or aluminium foil and allow them to stand, side by side, about 1/2 meter away from a 100-watt lamp in continuous operation.

Observe the jars every week for a period of several weeks and describe the color, density, and general appearance of the contents of each jar.

Where to Go from Here

- How does the color of the algae growing in the detergent solution compare with the color of the algae growing in the distilled water and why?
- Which solution would be best to grow fish in?
- What was the purpose of the 100-watt lamp in this experiment?
- Which solution would most closely compare to a polluted stream or pond?
- If this algae growth is bad for fish and other small pond life, how can we stop polluting ponds and streams with phosphates from washing detergents?

Other Things to Do

Test several different brands of detergent to determine if there is any difference in the effect which they have upon the growth of algae.

Place several minnows or goldfish in a small container which has a "thick" growth of green algae and contrast this with a similar group of fish in a container with a moderate growth of algae or a container with no visible algae growth.

Other Things to Think About

Many of the commercial dishwashing and automatic washer detergents used in homes contain soluble phosphates, which have a stimulating effect upon the growth of algae. Since the sewage from our cities, containing such phosphates, is eventually released into streams, lakes, and rivers, it has caused an increased growth of algae. This algae "bloom" as it is called, has a number of unfavorable effects upon the balance of plant and animal organisms in bodies of fresh water. The algae can use up the oxygen supply needed by fish and smaller aquatic organisms. Sunlight cannot penetrate the algae. Often the algae blocks proper drainage. Food and water supplies are thus adversely affected by this algae bloom, which is stimulated by the increased phosphate level in the fresh water ponds, streams, lakes, and rivers.

The algae grows by photosynthesis, which produces 0_2 as a by-product. Both algae and fish need 0_2 to survive. What happens in a pond or stream at night when the algae is not producing oxygen? Refer to the activity in photosynthesis to compare the effects of light.

GENETICS

Exercise "J"

Objectives

At the end of this activity the student should be able to

- Demonstrate the pattern of transmission of genes
- Classify Drosophila by phenotype
- Diagram the life cycle of an insect

Materials

Baby food jars
Two strains of Drosophila (wild type and vestigial brown eye or black body)
Drosophila culture medium
Cotton wool
Ether
Transparent tape
Toothpicks
Gummed labels

How to Get Started

Prepare a sufficient amount of Drosophila medium by mixing instant powder with water or by preparing your own following the directions given below.

30 gm powdered dry yeast
120 gm corn meal
24 gm agar
270 ml molasses (nonsulfur) or corn syrup
100 ml H_2O
10 ml propionic acid

Soak the yeast in water until completely wetted and smooth in texture. Mix with all ingredients above except propionic acid and add 1.6 liters of boiling water. Boil gently for 10 minutes and stir in the propionic acid or other mold inhibitor.* Pour into containers while still hot. Small baby food jars should be filled less than 1/4 full. This amount should make about 30-40 bottles. Plug the containers with cotton and store in a cool place. These culture jars may be prepared ahead of time and stored two or three weeks in a refrigerator. Each team will require at least four culture jars.

Make an etherizer by moistening a small wad of absorbent cotton wool with a few drops of ether and fastening it to the inside of a lid to a baby food jar. Shake flies into the empty jar and place the lid with the ether-soaked cotton quickly upon it. Flies will stop moving in a few seconds; they should then be removed immediately because overexposure to ether will kill them.

Obtain at least two strains of Drosophila from one of the supply centers.

What to Do in the Lab

Fly cultures should be kept at 23° C to 25° C. Place two or three pairs of flies in each of several culture jars. Be sure to keep the strains separate and clearly labeled. Each team should have a culture of both strains of flies. After three or four days, these parents may be removed and examined closely with a microscope or hand lens.

Particular attention should be given to recognition of males and females. Males have darkly pigmented abdomens and females have striped abdomens. Males have sex combs--dark, heavy bristles--on the second joint of the front legs. Probably the most reliable way to determine the sex of the fly is to examine the genitalia located at the tip of the abdomen. Examine both sexes in detail until you become very familiar with the differences between male and female anatomy. Also examine the differences between strains. Be sure that you can easily distinguish the mutant characters from the standard or wild strain.

*If propionic acid is not available, sodium benzoate may be substituted. Sodium benzoate may be purchased from a bakery or pharmacy. The amount of sodium benzoate to be used would be 0.1% of the total amount.

Examine the cultures every day. Note the larvae that are crawling on the culture medium and burrowing through it. On about the seventh or eighth day the larvae will crawl out of the food up the side of the jar and secrete a covering around itself. This is the pupal stage. Complete metamorphosis occurs during the next three or four days, after which time the adult flies will emerge from the pupa cases.

Drosophila females mate soon after emerging and they store sperm from the male on special sacks. Each egg is fertilized as it is laid. Because of this sperm storage, it is necessary to obtain females before they mate. Females which are less than 12 hours old will most likely still be virgin. Remove all adults from culture bottles in the morning, then collect females in the afternoon.

Place three or four virgin females of either the wild type or mutant strains in a fresh culture jar. Place three or four males of the other strain with them. These flies are the parental generation of the crosses you will make. After about three or four days these parents can be shaken into another fresh culture jar or they can be discarded. On about the eleventh or twelfth day the offspring, or first-generation flies, begin to emerge. Examine them carefully and determine which of the parents they are like.

Place about four pairs of the F_1 flies in a fresh culture jar. There is no need to collect virgin females this time because you want to cross two first-generation flies. Transfer or discard these parents after about four days. When the next generation (F_2) begins to emerge, count them and classify them as to whether they resemble the wild type or the mutant (P_1) flies. Also classify them as to sex.

Where to Go from Here

- What ratio of wild type to mutant type did you get?
- What ratio did you expect?
- Is the mutant trait a dominant or a recessive?
- What sex ratio did you get?
- Diagram the crosses you have done using letters to designate the genes (genotype) of the P_1, F_1, and F_2 individuals.
- What conclusions can you draw about the way traits are inherited?

Other Things to Do

Try making a cross between two mutant strains. Examine the F_1 and F_2 generations. Diagram the crosses so that you know what to expect each generation to be like.

- How is sex inherited in these flies?
- What would be the pattern of inheritance if the gene for one of the mutant characters was carried on the pair of chromosomes that determined sex?

HEREDITY AND NATURAL SELECTIONS: A MODEL SYSTEM

Exercise "J"

Objectives

At the end of this activity the student should be able to

- Predict the genetic makeup of a model population
- Explain heredity and natural selection

Materials

Marbles of two different colors, at least 100 of each color, or red and white beans of the same size, or toothpicks of 2 different colors
Boxes or paper bags

How to Get Started

Let marbles represent alternative forms of a gene. For example, one red could be for a taster gene (T) and blue could stand for nontaster allele (t). Each person in a population has two copies of each gene, one contributed by the mother and the other contributed by the father. Possible types (genotypes) are TT, represented by 2 red marbles, and Tt, represented by 1 red and 1 blue marble, and tt represented by 2 blue marbles. The proportion of each type will depend on the number of T compared to t in a population.

What to Do in the Lab

Mix equal numbers of two colors in a box and then pick a marble without looking. Record its color and replace it. Mix marbles and draw again. Let the two marbles drawn in two successive trials represent a gene combination (genotype) of a single individual. Draw until a population of 50 or 100 individuals is created. These can be tabulated in a chart.

Record:
the population pool by the appropriate figure. For example, if your population is 100 double red, 200 one red-one blue, and 100 double blue, the number of marbles to be placed in the box would be 300 red and 100 blue.

Create a next generation by drawing marbles as before. Reconstitute the population in the box according to the number recorded in each class, again leaving out a number of blue marbles equal to twice the double-blue category. Carry on in this fashion for several more generations, each time reducing the blues in the appropriate manner.

- What happens when such selection is exercised?

- Will the blue marbles ever disappear completely from the population?

Try repeating this where selection is against the one red-one blue combination as well as double blues.

- Can you relate this selection to what actually happens in nature?

AUDIO-VISUAL SOURCE INFORMATION

TITLE	TYPE	SOURCE	TIME	COLOR OR B/W
Adaptive Radiation - The Mollusks	16mm	Encyclopedia Britannica Films	18 min.	B/W
Age of Mammals	16mm	Encyclopedia Britannica Films	14 min.	C
Algae - Reproduction, Ulothrix	Trans.	General Aniline		C
Ameboid Organisms	16mm	X X X	28 min.	X
An Animal Life Cycle	16mm	McGraw-Hill Textfilms	28 min.	C
Angiosperms	16mm	Encyclopedia Britannica Films	21 min.	C
Angiosperms (Monocot and Dicot	Trans.	General Aniline 7 Film Corp.		C
Angiosperms (Stem Structure)	Trans.	General Aniline 7 Film Corp.		B/W
Angiosperms - The Flowering Plants	16mm	Encyclopedia Britannica Films	21 min.	C
An Animal Life Cycle	16mm	McGraw-Hill Textfilms	28 min.	C
Animal and the Environment	16mm	McGraw-Hill Textfilms	28 min.	C
Animal Predators and the Blance of Nature	16mm	Journal Films	10 min.	C
Animal Reproduction	16mm	Journal Films	17 min.	C
Ants	16mm	Encyclopedia Britannica Films	11 min.	B/W
ATP - A Packet of Energy	FS	Popular Science Pub. Company		C
Atomic Structure and Chemistry	FS	Popular Science Pub. Company		C
Autonomic Nervous System	Trans.	General Aniline 7 Film Corp.		C
Bacteria	16mm	McGraw-Hill Textfilms	28 min.	C
Bacteria - Friend and Foe	16mm	Encyclopedia Britannica Films	10 min.	B/W
Bacteria - Lab Study	16mm	Indiana University	16 min.	C

AUDIO-VISUAL SOURCE INFORMATION

TITLE	TYPE	SOURCE	TIME	COLOR OR B/W
Balance Your Diet for Health and Appearance	16mm	Coronet Films	11 min.	C
Big Green Caterpillar	16mm	Stanton Films	11 min.	C
Biochemistry and Molecular Structure	16mm	Modern Learning Aids	22 min.	C
Biological Communities	FS	Popular Science		C
Biology in Today's World	16mm	Coronet Films	11 min.	C
Birds and Their Characteristics	16mm	Coronet Films	11 min.	C
Blood, The	16mm	Encyclopedia Britannica Films	16 min.	C
Bryophytes, The	16mm	McGraw-Hill Textfilms	28 min.	C
Cave Community, The	16mm	Encyclopedia Britannica Films	13 min.	C
Cave Dwellers of the Old Stone Age	16mm	Encyclopedia Britannica Films	18 min.	C
Carbon and Its Compounds	16mm	Coronet Films	11 min.	B/W
Carnivorious Plants	16mm	Moody Institute of Science	28 min.	C
Cell Reproduction - Mitosis	16mm	McGraw-Hill Textfilms	28 min.	C
Cell Respiration	16mm	McGraw-Hill Textfilms	28 min.	C
Cell, The - Structural Unit of Life	16mm	Coronet Films	11 min.	C
Characteristics of Plants and Animals	16mm	Indiana University	10 min.	C
Chemical Organization of the Cell	16mm	McGraw-Hill Textfilms	28 min.	C
Chick Embryo - From Primitive Streak to Hatching	16mm	Encyclopedia Britannica	13 min.	B/W
Chlorophyll	16mm	McGraw-Hill Textfilms	28 min.	C
Choosing Your Career	16mm	Guidance Associates	11 min.	C

AUDIO-VISUAL SOURCE INFORMATION

TITLE	TYPE	SOURCE	TIME	COLOR OR B/W
Classification of Matter	FS	Encyclopedia Britannica Films		C
Classifying Plants and Animals	16mm	Coronet Films	11 min.	C
Colour of Life	16mm	Universal Education and Visual Arts	24 min.	C
Community, The	16mm	Encyclopedia Britannica Films	11 min.	B/W
Conserving Our Forests Today	16mm	Coronet Films	11 min.	C
Conserving Our Natural Resources Series	16mm	Encyclopedia Britannica Films	11 min.	C
Conserving Our Water Resources Today	16mm	Coronet Films	11 min.	C
Covalent Bonds - Covalent Structures	FS	Popular Science Pub. Company		C
Cracking the Code of Life	16mm	American Cancer Society, Conn Div	22 min.	C
Development of Embryos	FS	Popular Science Pub. Company		C
Diffusion and Osmosis	16mm	Coronet Films	11 min.	C
Digestion of Foods	16mm	Encyclopedia Britannica Films	11 min.	B/W
Dissection and Anatomy of the Earthworm	16mm	McGraw-Hill Textfilms	15 min.	C
Dissection and Anatomy of the Frog	16mm	McGraw-Hill Textfilms	15 min.	C
Dissection and Anatomy of the Mammalian Heart	16mm	McGraw-Hill Textfilms	15 min.	C
Distribution of Plants and Animals	16mm	Encyclopedia Britannica Films	16 min.	B/W
Diversity in Form and Size	16mm	McGraw-Hill Textfilms	28 min.	C
DNA - Code of Life	FS	Popular Science		C
Dr. Leakey and the Dawn of Man	16mm	Encyclopedia Britannica Films	26 min.	C

AUDIO-VISUAL SOURCE INFORMATION

TITLE	TYPE	SOURCE	TIME	COLOR OR B/W
Ears and Hearing, The	16mm	Encyclopedia Britannica Films	10 min.	B/W
Echinoderms - Sea Stars and Their Relatives	16mm	Encyclopedia Britannica Films	17 min.	B/W
Elements, Compounds and Mixtures	16mm	Modern Learning Aids	33 min.	C
Embryonic Development of Fish	16mm	National Film Board of Canada	28 min.	C
Embryonic Development - The Chick	16mm	National Film Board of Canada	26 min.	C
Endocrine Glands	16mm	Encyclopedia Britannica Films	11 min.	B/W
Enzymes - The Spark Plugs of Life	FS	Popular Science Pub. Company		C
Evolution of Vascular Plants - Fern	16mm	Encyclopedia Britannica Films	17 min.	C
Exploring the Human Nervous System	16mm	Churchill Film Company	23 min.	C
Eyes and Their Care	16mm	Encyclopedia Britannica Films	10 min.	B/W
Eyes and Vision	16mm	Encyclopedia Britannica Films	10 min.	B/W
Fern - Filicineae	Trans.	General Aniline 7 Film Corp.		C
First Many - Celled Animals - The Sponges	16mm	Encyclopedia Britannica Films	17 min.	C
Fish Embryo - From Fertilization to Hatching	16mm	Encyclopedia Britannica Films	12 min.	C
Fishes, Amphibians and Reptiles	16mm	McGraw-Hill Textfilms	28 min.	C
Flatworms - Platyhelminthes	16mm	Encyclopedia Britannica Films	16 min.	C
Flies and Mosquitoes: Their Life Cycle and Control	16mm	Encyclopedia Britannica Films	10 min.	C
Flight of Birds	16mm	Film Associates of California	13 min.	C
Flower Fertilization	Trans.	General Aniline 7 Film Corp.		C

AUDIO-VISUAL SOURCE INFORMATION

TITLE	TYPE	SOURCE	TIME	COLOR OR B/W
Flowers At Work	16mm	Encyclopedia Britannica Films	11 min.	C
Flowers: Structure and Function	16mm	Coronet Films	11 min.	C
Food, The Color of Life	16mm	Reid H Ray Film Industries, Inc.	23 min.	C
Foods and Nutrition	16mm	Encyclopedia Britannica Films	11 min.	B/W
Form and Function	16mm	McGraw-Hill Textfilms	28 min.	C
Frog Development - Fertilization to Hatching	16mm	Universal Eduction and Visual Arts	12 min.	C
Frog, The	16mm	Encyclopedia Britannica Films	11 min.	C
Fundamentals of the Nervous System	16mm	Out of Print	16 min.	B/W
Fungi	16mm	Encyclopedia Britannica Films	16 min.	B/W
Fungi - Life Cycle of Wheat Rust	Trans.	General Aniline 7 Film Corp.		C
Fungus Plants	16mm	Encyclopedia Britannica Films	9 min.	B/W
Gene Action	16mm	Encyclopedia Britannica Films	16 min.	B/W
Genes and Chromosomes	16mm	McGraw-Hill Textfilms	28 min.	C
Giving Our Wildlife a Chance	FS	Singer Educational Training		C
Great Names in Biology Series	FS	Encyclopedia Britannica Films		C
Growth of Plants	16mm	Encyclopedia Britannica Films	21 min.	C
Growt of Seeds	16mm	Encyclopedia Britannica Films	14 min.	C
Gymnosperms	16mm	Encyclopedia Britannica Films	17 min.	C
Heart and Circulation	16mm	Encylopedia Britannica Films	10 min.	B/W

AUDIO-VISUAL SOURCE INFORMATION

TITLE	TYPE	SOURCE	TIME	COLOR OR B/W
Heredity	FS	Popular Science Pub. Company		C
High Arctic Brome	16mm	Modern Learning Aids	23 min.	B/W
Higher Fungi, The	16mm	McGraw-Hill Textfilms	28 min.	C
Hot Dry Desert	16mm	Bailey	16 min.	C
Housefly, The	16mm	Encyclopedia Britannica Films	17 min.	C
Housefly and Its Control, The	16mm	Coronet Films	11 min.	C
How Hormones Control The Body	FS	Popular Science Pub. Company		C
Human Body - Muscualr System	16mm	Coronet Films	14 min.	C
Human Body, The - Nutrition and Metabolism	16mm	Coronet Films	14 min.	C
Human Brain	16mm	Encyclopedia Britannica Films	11 min.	B/W
In a Medical Laboratory	16mm	USNAC	28 min.	C
Ingestion and Digestion	16mm	McGraw-Hill Textfilms	28 min.	C
Inheritance in Man	16mm	McGraw-Hill Textfilms	28 min.	C
Insects	16mm	Encyclopedia Britannica Films	14 min.	C
Insects and Spiders	16mm	McGraw-Hill Textfilms	28 min.	C
Insect Metamorphosis	16mm	Film Associates of California	15 min.	C
Introducing Insects (Butterflies, Beetles and Bugs)	16mm	Encyclopedia Britannica Films	17 min.	C
Invertebrates, The	16mm	Coronet Films	14 min.	C

AUDIO-VISUAL SOURCE INFORMATION

TITLE	TYPE	SOURCE	TIME	COLOR OR B/W
Jointed-Legged Animals, The Arthropods	16mm	Encyclopedia Britannica Films	19 min.	C
Language of the Bees	16mm	Moody Films	15 min.	C
Laws of Heredity	16mm	Encyclopedia Britannica Films	15 min.	B/W
Leaf Photosynthesis	Trans.	General Aniline 7 Film Corp.		C
Leaves	16mm	Encyclopedia Britannica Films	11 min.	B/W
Life of a Plant	16mm	Encyclopedia Britannica Films	16 min.	C
Life Story of the Hummingbird	16mm	Encyclopedia Britannica Films	16 min.	C
Life Story of the Paramecium	16mm	Encyclopedia Britannica Films	11 min.	C
Magic of the Atom, The - Riddle of Photsynthesis	16mm	Atomic Energy Commission	15 min.	C
Man Makes a Desert	16mm	Film Associates of California	11 min.	C
Mechanisms of Breathing	16mm	Encyclopedia Britannica Films	11 min.	B/W
Meiosis - Sex Cell Formation	16mm	Encyclopedia Britannica Films	16 min.	C
Mental Health	16mm	Encyclopedia Britannica Films	12 min.	B/W
Microbes and Their Control	16mm	Film Associates of California	13 min.	C
Microscopic Life in the Soil	16mm	Stanton Films	14 min.	C
Mitois	16mm	Encyclopedia Britannica Films	24 min.	C
Mitois and Meiosis	16mm	Indiana University	17 min.	C
Monarch Butterfly Story	16mm	Encyclopedia Britannica Films	11 min.	C
Mosquito, The	16mm	Encyclopedia Britannica Films	11 min.	B/W
Moss - Mycel	Trans.	General Aniline 7 Film Corp.		C

AUDIO-VISUAL SOURCE INFORMATION

TITLE	TYPE	SOURCE	TIME	COLOR OR B/W
Muscles and Bones of the Body	16mm	Coronet Films	11 min.	B/W
Mystery of Life, The	16mm	McGraw-Hill Textfilms	25 min.	C
Natural Selection	16mm	Encyclopedia Britannica Films	16 min.	C
Natural Selection and Adaptation	16mm	McGraw-Hill Textfilms	28 min.	C
Nature of Diversity	16mm	McGraw-Hill Textfilms	28 min.	C
Nature's Cycles	FS	Popular Science Pub. Company		C
Nervous System	Trans.	General Aniline 7 Film Corp.		C
Nervous System (Brain)	Trans.	General Aniline 7 Film Corp.		C
Nervous System, Brain, Median Section	Trans.	General Aniline 7 Film Corp.		C
Nervous System, The	16mm	Encyclopedia Britannica Films	11 min.	B/W
Nose, The	16mm	Encyclopedia Britannica Films	11 min.	B/W
Orbitals - Atom and Molecular	16mm	Popular Science Pub. Company		C
Order in Diversity	16mm	McGraw-Hill Textfilms	28 min.	C
Origin of Land Plants - Liverworts and Mosses	16mm	Encyclopedia Britannica Films	14 min.	C
Origin of Life	16mm	McGraw-Hill Textfilms	28 min.	C
Osmosis	16mm	Encyclopedia Britannica Films	17 min.	C
Our Changing Way of Life - Cattleman - A Rancher's Story	16mm	Encyclopedia Britannica Films	22 min.	
Our Friend, The Atom Part I	16mm	Walt Disney	24 min.	C
Our Friend, The Atom Part II	16mm	Walt Disney	24 min.	C

AUDIO-VISUAL SOURCE INFORMATION

TITLE	TYPE	SOURCE	TIME	COLOR OR B/W
Paramecuim, Euglena and Amoeba	16mm	Educational Services	15 min.	C
Parasitism (flatworms)	16mm	Encyclopedia Britannica Films	17 min.	C
Parasitism - Parasitic Flatworms	16mm	Encyclopedia Britannica Films	17 min.	C
Patterns of Reproduction	16mm	McGraw-Hill Textfilms	28 min.	C
Phagocytes - The Body's Defenders	16mm	Stanton Films	10 min.	C
Photosynthesis	16mm	Out of Print	21 min.	C
Photosynthesis: Chemistry of Food-Making	16mm	Coronet Films	14 min.	C
Physical Environment, The	16mm	Encyclopedia Britannica Films	11 min.	C
Plankton and the Open Sea	16mm	Encyclopedia Britannica Films	19 min.	C
Plant - Animal Communities - Physical Environment	16mm	Coronet Films	11 min.	C
Plant Growth	16mm	Encyclopedia Britannica Films	11 min.	B/W
Plant Organism, The	16mm	McGraw-Hill Textfilms	28 min.	C
Plant Reproduction	16mm	McGraw-Hill Textfilms	28 min.	C
Plant Tropisms and Other Movements	16mm	Coronet Films	11 min.	C
Plants and Animals Under the Sea	FS	Singer Educational Training		C
Population Ecology	16mm	Encyclopedia Britannica Films	19 min.	B/W
Population Ecology	16mm	McGraw-Hill Textfilms	28 min.	C
Protozoa (One-Celled Animals)	16mm	Encyclopedia Britannica Films	11 min.	C

AUDIO-VISUAL SOURCE INFORMATION

TITLE	TYPE	SOURCE	TIME	COLOR OR B/W
RNA and Protein Synthesis	FS	Popular Science Pub. Company		C
Roots of Plants	16mm	Encyclopedia Britannica Films	11 min.	B/W
Science of Genetics, The	16mm	McGraw-Hill Textfilms	28 min.	C
Seed Germination	16mm	Encyclopedia Britannica Films	15 min.	B/W
Seeds and Germination	16mm	McGraw-Hill Textfilms	28 min.	C
Segmentation - The Annelid Worms	16mm	Encyclopedia Britannica Films	16 min.	B/W
Simple Plants - The Algae	16mm	Encyclopedia Britannica Films	18 min.	C
Single - Celled Animals - Protozoa	16mm	Encyclopedia Britannica Films	17 min.	B/W
Social Insects - The Honeybee	16mm	Encyclopedia Britannica Films	24 min.	B/W
Species - Stability and Change	16mm	McGraw-Hill Textfilms	28 min.	C
Spinal Column	16mm	Encyclopedia Britannica Films	11 min.	B/W
Standing Room Only	16mm	McGraw-Hill Textfilms	25 min.	C
Stem Structure	Trans.	General Aniline 7 Film Corp.		C
Stinging - Celled Animals - Coelenterates	16mm	Encyclopedia Britannica Films	17 min.	C
Story of Bees	16mm	Encyclopedia Britannica Films	11 min.	B/W
Story of the Bloodstream Reel I	16mm	Moody Films	26 min.	C
Story of the Bloodstream Reel II	16mm	Moody Films	26 min.	C
Succession - From Sand Dune to Forest	16mm	Encyclopedia Britannica Films	16 min.	B/W
Systematic Scientist, The	16mm	McGraw-Hill Textfilms	24 min.	C
Temperate Deadious Forest	16mm	Encyclopedia Britannica Films	17 min.	B/W

AUDIO-VISUAL SOURCE INFORMATION

TITLE	TYPE	SOURCE	TIME	COLOR OR B/W
Theories of Development	16mm	McGraw-Hill Textfilms	28 min.	C
Tissues of the Human Body	16mm	Churchill Films	17 min.	C
Tropical Rain Forest, The	16mm	Encyclopedia Britannica Films	17 min.	C
Vascular Plants	Trans.	General Aniline 7 Film Corp.		C
Viruses	16mm	McGraw-Hill Textfilms	28 min.	C
What Is a Bird?	16mm	Encyclopedia Britannica Films	17 min.	C
What Is a Cell?	16mm	McGraw-Hill Textfilms	28 min.	C
What Is a Fish?	16mm	Encyclopedia Britannica Films	22 min.	C
What Is a Mammal?	16mm	Encyclopedia Britannica Films	14 min.	C
What Is a Reptile?	16mm	Encyclopedia Britannica Films	18 min.	B/W
What Is an Amphibian?	16mm	Encyclopedia Britannica Films	11 min.	C
What Is Ecology?	16mm	Encyclopedia Britannica Films	11 min.	B/W
What You Should Know Before You Go to Work	16mm	Guidance Associates	14 min.	C
What's In the Atom?	FS	Popular Science Pub. Company		C
Work of the Blood	16mm	Encyclopedia Britannica Films	13 min.	C
Work of the Kidneys	16mm	Encyclopedia Britannica Films	10 min.	B/W

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1537 Thirty-fifth Street NW
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2. American Academy of Ophthalmology
and Otolaryngology
15 Second Street S.W.
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3. American Association for Inhalation
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3554 Ninth Street
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4. American Association of Museums
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5. American Association of Nurserymen
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7. American Chemical Society
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11. American Medical Association
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12. American Medical Women's Association
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13. ANA-NLN Nursing Career Program
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14. American Occupational Therapy Association
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15. American Pharmaceutical Association
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16. American Registry of Inhalation Therapists
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17. American Society of Biological Chemists
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18. American Society of Limnology and
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19. American Society of Medical Technologists
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20. American Society of Zoologists
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21. American Sociological Association
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22. American Speech and Hearing Association
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23. American Turnabout Association
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San Diego, California 92101

24. Association of American Medical Colleges
2530 Ridge Avenue
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25. Association for Research in Ophthalmology
University of Florida College of Medicine
Gainville, Florida 32603

26. Association of University Programs in
Hospital Administration
1642 East 56th Street
Chicago, Illinois 60637

27. Botanical Society of America, Inc.
c/o Department of Botany
Rutgers University
New Brunswick, New Jersey 08903

28. Bureau of Sport Fisheries and Wildlife
Fish and Wildlife Service
U.S. Department of the Interior
Washington, D.C. 20240

29. EMBA Mink Breeders Association
3103 Lathrop
Racine, Wisconsin 53405

30. Empress Chinchilla Breeders Cooperative, Inc.
145 West 30th Street
New York, New York 10001

31. General Adjustment Bureau
123 William Street
New York, New York 10038

32. Glouster Master Mariners Associations
23 Duncan Street
Glouster, Massachusettes 01930

33. Golf Course Superintendents Association
of America
Des Plaines, Illinois 60018

34. Health Careers Council of Illinois
410 North Michigan Avenue
Chicago, Illinois 60611

35. Institute of Food Technologists
221 North La Salle Street
Chicago, Illinois 60601

36. International Brotherhood of Teamsters,
Chauffers, Warehousemen and Helpers of
America
25 Louisiana Avenue, N.W.
Washington, D.C. 20001

37. International Shade Tree Conference
1827 Neil Avenue
Columbus, Ohio 43210

38. Medical Library Association
919 Michigan Avenue
Chicago, Illinois 60611

39. National Arborist Association
616 Southern Building
Washington, D.C. 20005

40. National Association of Gardeners
194 Old Country Road
Mineola, New York 11501

41. National Association of Hearing and Speech Agencies
919 Eighteenth Street N.W.
Washington, D.C. 50006

42. National Association of Independent Insurance Adjusters
175 W. Jackson Boulevard
Chicago, Illinois 60604

43. National Association for Pratical Nurse Education and Service
1465 Broadway
New York, New York 10036

44. National Association of Public Insurance Adjusters
1613 Munsey Building
Baltimore, Maryland 21202

45. National Board of Fur Farm Organization, Inc.
152 West Wisconsin Avenue
Milwaukee, Wisconsin 53203

46. National Council on Crime and Delinquency
44 East 23rd Street
New York, New York 10010

47. National Fisheries Institute
125 Connecticut Avenue, N.W.
Washington, D.C. 20036

48. National Health Council
Health Careers Program
1740 Broadway
New York, New York 10019

49. National Landscape Nurserymen's Association
832 Southern Building
Washington, D.C. 20005

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8 South Michigan Avenue
Chicago, Illinois 60603

51. Registry of Medical Technologists of the American Society of Clinical Patholists
Box 4872
Chicago, Illinois 60680

52. Southeastern Fisheries Association
330 South Adams Street
Tallahassee, Florida 32301

53. Special Libraries Association
31 East 10th Street
New York, New York 10003

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729 Fifteenth Street N.W.
Washington, D.C. 20005

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   Riverside, California 92501

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   1790 Broadway
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   Ojileway Building
   Duluth, Minnesota 55802

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   135 W. Jackson Boulevard
   Chicago, Illinois 60604

5. American Journal of Botany
   c/o Department of Plant Sciences
   University of Oklahoma
   Norman, Oklahoma 73069

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   Houston, Texas 77025

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   251 Park Avenue South
   New York, New York 10010

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   2115 Constitution Avenue, N.W.
   Washington, D.C. 20037

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   1001 Connecticut Avenue N.W.
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    Journal of Speech and Hearing Disorders
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    9030 Old Georgetown Road

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    250 West 57th Street
    New York, New York 10019

12. Best's Fire and Casuality Insurance News
    75 Fultan Street
    New York, New York 10038

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    1155 Sixteenth Street, N.W.
    Washington, D.C. 20006

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    919 North Michigan Avenue
    Chicago, Illinois 60611

15. Empress Chinchilla
    Post Office Box 145
    Middletown, New York

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    624 Gravier Street
    New Orleans, Louisana 70130

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    461 Eighth Avenue
    New York, New York 10001

19. Food Technology
    221 North La Salle Street
    Chicago, Illinois 60601

20. Golf Superintendent, The
    3158 Des Plaines Avenue
    Des Plaines, Illinois 60018

21. Grounds Maintenance
1014 Wyandotte Street
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22. Hospital Administration
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23. Hospital Management
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25. Investigative Ophthalmology
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428 East Preston Street
Blatimore, Maryland 21200

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221 North La Salle Street
Chicago, Illinois 60601

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1010 Sixteenth Street NW
Washington, D.C. 20036

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2100 West Harrison Street
Chicago, Illinois 60612

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2530 Ridge Avenue
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Chicago, Illinois 60654

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194 Old Country Road
Mineola, New York 11501

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825 South Barrington Avenue
Los Angeles, California 90040

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1 Rickenbacker Causeway
Virginia Key, Miami, Florida 33149

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31 East 10th Street
New York, New York 10003

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Olmstead Falls, Ohio 44138

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152 West Wisconsin Avenue
Milwaukee, Wisconsin 53203

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1900 Euclid Avenue
Clevland, Ohio 44115